The Journal

OF THE

Royal United Service Institution.

VOL. VIII. 1864. No. XXXIII.

LECTURE.

Friday, May 27th, 1864.

HIS GRACE THE DUKE OF SOMERSET, K.G., First Lord of the Admiralty, in the Chair.

SOME NEW POINTS IN THE HISTORY AND APPLICATION OF GUN-COTTON.

By F. A. ABEL, Esq., F.R.S., Chemist to the War Department, Royal Arsenal, Woolwich.

MR. ABEL: About thirty years ago two substances were discovered in France, possessing new and curious properties. These substances, though they have never received any important application, are interesting, inasmuch as they are the precursors of gun-cotton, and furnished the germ of the discovery of that material.

In 1832 a French chemist, Braconnet, made the discovery that, by dissolving common starch in nitric acid (or *aquâ fortis*), keeping the mixture cold, and then adding water, he again separated what appeared to be the starch from the solution. But this substance was found to have undergone a curious change. Instead of burning, as it ordinarily does, slowly, with a steady flame, and leaving a carbonaceous residue, it had become to a considerable extent explosive; that is to say, it burned rapidly upon the application of flame, and much more brilliantly than when in its original condition, leaving little, if any, residue. A few years afterwards, another French chemist, Pelouze, now Master of the Mint in France, found that if he immersed common unsized paper, or ordinary cotton- or linen-fabrics, in nitric acid, also keeping the latter perfectly cool, this treatment imparted to those substances highly inflammable and almost explosive properties,

though in their appearance they were little, if at all, changed. A piece of paper operated upon in this way burns with almost explosive violence; a piece of calico burns as though it were saturated with some one of our most powerful oxidising materials, such as chlorate of potash.

The substance obtained from starch was called *Xyloïdin*, that furnished by linen or cotton was named *Pyroxilin*. The latter, prepared as just described, was obtained in an impure form; and it was not until 1846 that this substance was found by Schönbein to be produced in a much purer state by pouring cold nitric acid, or a cold mixture of nitric and sulphuric acids, upon ordinary carded cotton wool. The cotton wool appeared to undergo no change whatever; it still retained its ordinary form and appearance, feeling perhaps a little more crisp and harsh after the treatment. But it was converted into a powerful explosive substance, which Schönbein first described under the name of *gun-cotton;* a substance burning without smoke and without leaving any appreciable residue, and endowed with much higher explosive power than ordinary gunpowder.

Such a discovery as this naturally excited very considerable interest, particularly among military authorities; and experiments were at once set afloat, not only in Germany, but in France and in this country; experiments of very considerable interest and, some of them, carried out upon an extensive scale, for the purpose of determining the properties of this new explosive material.

In France, a factory was established; a considerable quantity of the material was prepared, and several of the most eminent military authorities, Piobert, Morin and others, carried on a series of most interesting experiments, the object of which was a strict comparison of gun-cotton with gunpowder. Unfortunately, these investigations, which were yielding very important practical results, and which promised before long to show clearly and definitely what was the value of this new material, were soon put a stop to by most lamentable accidents, which occurred, on two or three occasions, at or near the manufactory where this substance was being produced. Magazines containing gun-cotton, near which, it was stated, persons had not been for several days or weeks, exploded with very disastrous results; in short, the material was soon believed to be so utterly dangerous that no possible confidence could be placed in it.

In England, experiments, in the first instance of a scientific character, and afterwards of a practical nature, were instituted by chemists, gunpowder-manufacturers, artillery and other officers. Messrs. Hall, at Faversham, prepared the substance in considerable quantities; but not very long after their factory was established, a very lamentable explosion occurred there also. Large quantities of the material were ignited, it was believed (and is still, by the Messrs. Hall themselves), by the spontaneous combustion of the material, in consequence of some chemical change which it had undergone, and several lives were sacrificed by this calamity. This, of course, put a stop to the preparation of gun-cotton in this country, and since that period it has only occasionally received the attention of English

chemists, who have endeavoured to examine the substance more thoroughly. One of them especially, Mr. Hadow, has thrown more light on the nature of the substance than had previously been obtained by experiments in other countries.

In Germany, after a very short series of experiments, instituted immediately upon Schönbein's discovery, the material was pronounced to be altogether inapplicable to military purposes, by a committee appointed by the German Confederation. But, upon this committee there was an Austrian officer, Baron von Lenk, who considered the substance to possess certain valuable properties which rendered it worthy of further investigation. He continued to devote his attention to the subject, as is well known to many whom I am addressing, with varied success. At one time the material, which was again investigated by a committee appointed by the Austrian Government in 1852, was introduced to some considerable extent into the Austrian service; and experiments were carried out on its application to artillery, mining, and other purposes. Then some accidents occurred, or some discoveries unfavourable to its use were made, and it was discarded for a time. This varied success has continued almost up to the present time. A manufacturing establishment near Vienna was arranged, in 1852, for the preparation of the material on a large scale, and it is still produced there, I believe, abundantly, according to the improved system of manufacture, which is the result of Baron von Lenk's persevering labours. It is said that the material is used at the present time to some extent in the Austrian service, and that, after recent careful investigation, it is again likely to be adopted as a substitute for gunpowder for many military and industrial purposes.

About two years ago, the Austrian Government communicated confidentially to the Government of this country the general nature and preparation of gun-cotton, whereupon I was entrusted with the investigation of the manufacture of the material, and with the institution of such experiments as might suggest themselves to me, for the purpose of determining, in the first instance, whether it was really a safe material to operate with. In the course of the autumn in the same year, General Sabine, the president of the Royal Society, brought before the notice of the British Association the progress which appeared to have been made in the manufacture and application of gun-cotton by the Austrians; and a committee was appointed, consisting of chemists and engineers, for the purpose of investigating the subject. This committee placed itself in communication with the Government of this country, and also with General von Lenk, whom they invited over to meet them, and who was authorised by the Austrian Government to communicate to them full details with regard to the manufacture and the general effects and properties of the material. A preliminary report was presented by the British Association Committee at the general meeting last year, and the Council afterwards submitted to the Secretary of State for War a recommendation that a Royal Commission should be appointed to investigate the subject in all its bearings. Eventually, a special committee was appointed by the Government, consisting—partly of

scientific men, members of the British Association and Fellows of the Royal Society, and partly of military and naval men of eminence, to whom has been entrusted the examination into the manufactory of gun-cotton, into the permanence and general properties of the material, and into the possibility of applying it in the various directions in which gunpowder is used for military, naval, and industrial purposes.

This, then, is an outline of the history of the material up to the present period. Although the investigation of the subject in this country has only just been commenced, certain important and new results have already been arrived at, which throw considerable light upon the nature of the material, and also upon the uses to which it may be applied.

I shall now have the pleasure of giving you as connected an account as I can of the properties of gun-cotton, as far as we are at present acquainted with them. If you will allow me, I will first, without going into the chemistry of the matter, yet without altogether avoiding it, endeavour to make clear what gun-cotton really is. When we act upon such a substance as cotton-wool with nitric acid, which contains stored in it a large quantity of oxygen combined with the elements nitrogen and hydrogen, we bring the chemical activity of the nitric acid to bear upon certain constituent-particles of the cotton-wool. If I represent by this painted block an atom of cotton wool, and by this block a certain quantity of nitric acid, I shall be able in a simple manner to render apparent the change which the former undergoes. We have here cotton wool, composed of carbon, hydrogen, and oxygen; and here we have nitric acid, which, I say, contains a large quantity of oxygen, together with nitrogen and hydrogen. Now, when these substances are mixed together, the mixture being kept at a moderately low temperature, a certain portion of the cotton-wool is assailed by the nitric acid. The hydrogen, which is more easily oxidisable than the carbon in the cotton, is attacked by the nitric acid; a portion of it is removed from the little group of elementary atoms which form the cotton wool; and, as it is removed, a portion of the elements of the nitric acid (forming the group known as peroxide of nitrogen) enters into its place; the hydrogen that is thrown out or abstracted from the cotton is converted into water. We can go on in this way acting successively upon different atoms of the hydrogen contained in the cotton-wool: abstracting a second atom, for example, converting it into water, and introducing into its place a second molecule of the peroxide of nitrogen. By the substitution of the latter for hydrogen in the cotton, in this manner, we convert that substance into an explosive body; because we introduce a much larger proportion of oxygen into the cotton-wool than it originally contained; and this oxygen is ready at any moment, if aided by an elevation of temperature, or by other accelerating causes, to act upon the carbon and hydrogen, and convert them into gases and vapour, with almost instantaneous rapidity. In this way ordinary cotton may be converted into explosive substances, which vary in their composition and characters according to the number of atoms of hydrogen which have been acted upon. Thus, the substance obtained by the removal

of the lowest proportion of hydrogen is the least explosive, and has the same composition as the material which I described as being obtained from starch; while, by exposing the cotton to the action of a larger proportion of nitric acid, we obtain the most explosive product, the substance commonly known as gun-cotton, which has some puzzling names given to it by chemists. It is called trinitrocellulose; it is also called pyroxilin. Trinitrocellulose is the chemical term which accurately describes its composition, but "gun-cotton" will answer our purpose. We see, therefore, that this substance is produced by abstracting a certain proportion of hydrogen from the cotton-wool, and introducing peroxide of nitrogen in its place.

Intermediate between the most and least explosive bodies obtained from cotton, two other substances of analogous nature may be produced by employing different proportions of nitric acid. These substances are less explosive than gun-cotton, but more so than the starch compound, or the corresponding product from cotton. They dissolve in a mixture of ether and spirit, and produce that well-known substance collodion, which is of great importance to photographers, electricians, and medical men. I need hardly remind you that this collodion has been one of the most important agents in the development of photography. Here we have portions of cotton-wool which have been treated with different proportions of nitric acid. I am not able to distinguish between them, as they are identical in appearance, but the manner in which these substances burn will directly indicate which has been acted upon by the largest proportion of nitric acid. One is evidently the true gun-cotton; the other is the less explosive substance which furnishes collodion. We can, moreover, easily distinguish between the two by adding to each a small quantity of the mixed solvents used for preparing collodion. The gun-cotton becomes somewhat condensed by being soaked in that liquid, but the least explosive product is almost immediately dissolved.

According to Schönbein's original prescription, the cotton was to be saturated with a mixture of one part of nitric acid (of specific gravity 1·5) and three parts of sulphuric acid, (specific gravity 1·85) and allowed to stand for one hour. In operating upon a small scale, the treatment of cotton with the acid for that period is quite sufficient to effect its complete conversion into the most explosive product, pyroxilin, or trinitrocellulose. There is a small specimen of gun-cotton which I prepared strictly according to Schönbein's directions, soon after they were published in 1846. It is unquestionably pure gun-cotton or trinitrocellulose, and has undergone not the slightest change. But when the quantity of cotton treated at one time is considerable, especially if it be not very loose and open, its complete conversion into pyroxilin is not effected with certainty, unless it be allowed to remain in the acids for several hours. This accounts in great measure for the want of uniformity observed in the composition of gun-cotton, and its effects as an explosive, in the earlier experiments instituted; and it is, moreover, very possible that the want of stability, and consequently even some of the accidents which it was considered could only be ascribed to the spontaneous ignition of the material, might have been

due to the comparatively unstable character of the lower products of substitution, some of which existed in the imperfectly prepared gun-cotton.

The system of manufacture of gun-cotton elaborated by General von Lenk is founded upon that described by Schönbein; the improvements which the former has adopted all contribute importantly to the production of a thoroughly uniform and pure gun-cotton; there is only one step in his process which is certainly not essential, and about the possible utility of which chemical authorities are decidedly at variance with General von Lenk.

The following is an outline of the process of manufacture of gun-cotton as practised by Lenk. The cotton, in the form of loose yarn of different sizes, made up into hanks, is purified from certain foreign vegetable substances, by treatment for a brief period with a weak solution of potashes, and subsequent washing. It is then suspended in a well-ventilated hot-air chamber until all moisture has been expelled, when it is transferred to air-tight boxes or jars, and at once removed to the dipping tank, or vessel where its saturation with the mixed sulphuric and nitric acids is effected. The acids, of the specific gravity prescribed by Schönbein, are very intimately mixed in a suitable apparatus, in the proportions originally indicated by that chemist, *i.e.*, three parts by weight of sulphuric acid to one of nitric acid. I should explain that sulphuric acid is not used for the purpose of exerting any chemical action upon the cotton, but merely for promoting the action of the nitric acid. Strong sulphuric acid or oil of vitriol has a remarkable tendency to combine with water, and this property is usefully applied in the manufacture of gun-cotton, for the purpose of abstracting water, which the nitric acid contains, and thus rendering the latter more concentrated, and also for preventing the water, which, as you know, is produced in the chemical change, from interfering with the action of the nitric acid upon the cotton.

The mixture of acids is always prepared some time before it is required, in order that it may become perfectly cool. The throughly dry cotton is immersed in a bath of the mixed acids, one skein at a time, and stirred about for a few minutes until it has become thoroughly saturated with the acids; it is then transferred to a shelf in this dipping trough, where it is allowed to drain, and slightly pressed, to remove any large excess of acid; and is afterwards placed in an earthenware jar, provided with a tightly fitting lid, which receives six or eight skeins, weighing from two to four ounces each. The cotton is tightly pressed down in the jar, and if there be not sufficient acid present just to cover the mass, a little more is added; the proportion of acid to be left in contact with the cotton being about 10½ pounds to one pound of the latter. The charged jars are set aside for 48 hours in a cool place, where, moreover, they are kept surrounded by water to prevent the occurrence of any elevation of temperature, and consequent destructive action of the acids upon the gun-cotton. The same precaution is also taken with the dipping-trough, as considerable heat is generated during the first saturation of the cotton with the acids. At the expiration of 48 hours, the gun-cotton is transferred from the

jars to a centrifugal machine, by the aid of which the excess of acid is removed as perfectly as is possible by mechanical means, the gun-cotton being afterwards only slightly moist to the touch. The skeins are then immersed singly in water, and moved about briskly, so as to become completely saturated with it as quickly as possible. This result is best accomplished by plunging the skeins under a fall of water, so that they become at once thoroughly drenched. If they were simply thrown into water and allowed to remain at rest, the heat produced by the union of a portion of the free acids with a little water would be so great as to establish at once a destructive action upon the gun-cotton by the acid present. The washing of the separate skeins is continued until no acidity can be detected in them by the taste; they are then arranged in frames or crates and immersed in a rapid stream of water, where they remain undisturbed for two or three weeks. They are afterwards washed by hand, to free them from mechanical impurities derived from the stream, and are immersed for a short time in a dilute boiling solution of potashes. After this treatment they are returned to the stream, where they again remain for several days. Upon their removal they are once more washed by hand, with soap if necessary; the pure gun-cotton then only requires drying to render it ready for use. A supplementary process is, however, adopted by General von Lenk, about the possible advantage or use of which his opinion is not shared by others, as already stated. This treatment consists in immersing the air-dried gun-cotton in a moderately strong hot solution of soluble glass (silicate of potassa or soda), for a sufficient period to allow it to become completely impregnated; removing the excess of liquid by means of the centrifugal machine; thoroughly drying the gun cotton, thus "silicated," and finally washing it once more for some time, until all alkali is abstracted. Lenk considers that, by this treatment, some silica becomes deposited within the fibre of the gun-cotton, which, on the one hand, assists in moderating the rapidity with which the material burns, and, on the other hand, exercises (in some not very evident manner) a preservative effect upon the gun-cotton, rendering it less prone to undergo even slight changes, by keeping. The mineral matter contained in pure gun-cotton which has not been submitted to this particular treatment amounts to about one per cent. The proportion found in specimens which have been "silicated" in Austria and in this country, according to Lenk's directions, varies between 1·5 and 2 per cent. It is difficult to understand how the addition of one per cent. to the mineral matter, in the form chiefly of silicates of lime and magnesia (the bases being derived from the water used in the final washing), which are deposited upon and between the fibres in a pulverulent form, can influence, to any material extent, either the rate of combustion or the keeping qualities of the product obtained by Lenk's system of manufacture.

The gun-cotton, when thus prepared, is carefully dried and stored in well ventilated rooms, heated to about 80° Fahrenheit. This is the only operation where there is any possibility of danger. The manufacture of this material possesses most important advantages over that of gunpowder. In the manufacture of the latter, the opera-

tions are all of a dangerous character, from the moment the materials are mixed up to the final drying process; while this is the case with gunpowder, the processes to which cotton-wool is submitted for conversion into pure gun-cotton are all harmless; and it is only when it reaches the drying process that any risk of accident can occur. But if this drying process be conducted with care, the temperature of the room being carefully regulated, there is really no actual danger, even in this operation. It merely requires attention to the precautions ordinarily used in the manufacture of gunpowder, such as the exclusion of possible sources of fire, to ensure the safety of the drying process.

The question of the permanence and keeping properties of the pure gun-cotton, and, therefore, of its safety as a material to be preserved in store, or used in military or naval service, is still enveloped in uncertainty. We know that gun-cotton may be preserved for a great length of time without undergoing any change. The small specimen, prepared in 1846, which I just now showed you, is one example of the possibility of keeping gun-cotton without change. That sample was kept in a box, generally closed, and but rarely exposed to light. But here is another specimen, which I did not prepare myself, but which was given to me two or three years ago as a specimen of very carefully prepared gun-cotton. I should rather say, this *was* a specimen of gun-cotton, for the only evidence we have of the existence of that material is the presence, in the bottle, of certain products which chemists know to be formed during the spontaneous change which imperfectly prepared gun-cotton will undergo. Here, again, are specimens, prepared in 1847, by Messrs. Hall, about the time they had that lamentable explosion at their works. A quantity of gun-cotton existed in store, and they, anxious to get rid of this dangerous material, at once buried the whole quantity in a hole dug in the ground; and there it has been ever since. They were kind enough to have a small quantity dug up for me a short time ago, and this is a specimen of the material. It appears to have undergone no chemical change whatever, having been preserved in a wet or thoroughly damp condition for about 17 years. Though not the most explosive form of gun-cotton, and therefore possibly a comparatively unstable material, yet, buried in this way, it has kept perfectly well. Upon examining it by means of test-papers, and soon after its disinterment, I found that there was no trace of free acid in it. But as soon as I exposed a portion of it to light, or very shortly afterwards, it began to exert an action upon test-paper. This gun-cotton, which has been so permanent in its character for a number of years, begins therefore to change as soon as it is exposed to the light, and this change is much accelerated by the action of heat. It is found to take place, not only in this particular gun-cotton, which has been imperfectly prepared, but also in the material produced strictly according to Lenk's directions. If I expose gun-cotton in an exhausted glass globe to the action of air and light, some gaseous matter is generated; if I modify that experiment by exposing the globe to heat, which I can do by keeping it surrounded with hot water, the change takes place more rapidly and to a greater extent.

Whether this change is so important as to influence vitally the permanence of the material,—whether gun cotton, when exposed to light or heat until it begins to undergo this slight change, and then stored in the dark, will continue to decompose,—whether the changes which it may therefore undergo by travelling in limber-boxes in tropical countries, are likely to continue if the material should be returned into magazines,—these are most important points, which will require very careful investigation at the hands of the Government committee. They are naturally points of the highest interest in connection with the possible susceptibility of gun-cotton to application in warfare, inasmuch as, unless we can positively prove, without any chance of dispute, that the material is thoroughly permanent, any advantages which it may possess as an explosive agent over gunpowder will go for nothing at all.

Now, let me pass to the properties of gun-cotton, and first of all to those by which we have until lately been in the habit of recognising it. You perceive that cotton, when thus treated with nitric acid, does not appear at first sight to have undergone any change. It appears a little more crisp and harsh than the original cotton; and another indication of its having undergone some physical change, is furnished by the fact, that it absorbs less moisture. Carded cotton-wool, in its purest form, absorbs from the air about six per cent. of water; gun-cotton absorbs two per cent. of moisture. If it is dried, it speedily takes up that proportion of moisture again. If it is exposed to a very damp atmosphere, it absorbs about six per cent. of moisture; but when exposed again to ordinarily dry air, it soon loses all above two per cent. This is an important advantage which it has over gunpowder. We know that, if we expose gunpowder to a moist atmosphere, or store it in a damp magazine, it will gradually and continuously absorb moisture, until it becomes perfectly pasty; and that it is necessary again to submit powder which has become damp, to the manufacturing processes, in order to reconvert it into good gunpowder.

Gun-cotton explodes readily without smoke, and without leaving any appreciable residue. It inflames at a very low temperature as compared with gunpowder, although not at so low a temperature as was originally supposed. It is found that gun-cotton may be raised to 280 or even 300 degrees of Fahrenheit, without undergoing explosion; but these are low temperatures compared with that to which gunpowder may be heated before it explodes. I will show you the ready explosibility of gun-cotton, by introducing some, contained in this glass tube, into a vessel containing a saline solution, which is heated to a temperature of 300 degrees. You will see that the gun-cotton is in a very short time raised to a temperature at which it explodes. Gun-cotton also explodes by friction; when submitted to the friction produced by a powerful blow, it is easily ignited, with explosive violence, and converted into gaseous matter. If I take a small piece of gun-cotton, and hit it a moderate blow on this anvil, I have no doubt I shall succeed in detonating that portion of it which is immediately under the hammer, but that portion which projects beyond will remain

unexploded. Gunpowder is not generally believed to be exploded by detonation, nor is it so in the ordinary acceptation of the term. We may hit gunpowder very hard indeed on an anvil, and we shall fail to explode it, unless we happen to strike a spark with the hammer out of the anvil. In this instance, you hear that I produce a very slight detonation; and I could increase it by wrapping the powder up in tinfoil, so as to confine the heat. A short time ago, Mr. Scott Russell, in a lecture which he delivered on gun-cotton, stated and showed experimentally that gunpowder was more detonating than gun-cotton. This was a new fact to those who know what gunpowder is; and Mr. Scott Russell, in performing his experiments, must have got hold of a very remarkable specimen of that material.

Gun-cotton exhibits another curious property, one which was demonstrated just now when I showed that, in striking a mass of gun-cotton with a hammer, I do not explode that portion which is not immediately under the hammer. When gun-cotton is compressed at any particular part, powerfully or even moderately, and lighted at any other portion, the compressed part will not burn, and therefore the combustion will not extend beyond it. If I press with a card upon the centre of a piece of gun-cotton laid upon a flat surface, I can fire the gun-cotton on one side of the card, and it will not burn on the other.

Gun-cotton, in its ordinary condition, explodes much more rapidly than gunpowder. This has been evident in the one or two experiments I have already made. If I ignite gun-cotton, the flame produced is far more instantaneous in its character than that produced by the explosion of gunpowder. I may give you an illustration of the difference between the rapidity of the burning of gunpowder and of gun-cotton. I place a small portion of gunpowder on the centre of a tuft of gun-cotton, and then apply flame to the gun-cotton; if I am successful, I shall ignite the gun-cotton, and the flash of flame produced will not have time to ignite the gunpowder. Now this great rapidity of combustion constituted one of the most important objections that have been raised against the employment of gun-cotton in firearms. Although many attempts have been made at different times to modify the rapidity of the explosive action of gun-cotton, so as to render it applicable to general military purposes, only one system, and that the most simple of all, has been attended with success. By modifying the mechanical condition of the material, so as render it more or less compact in its character, the rapidity with which it explodes, in open air, may be regulated to almost any extent. If I render a piece of this tuft of gun-cotton more compact, by twisting it up between my fingers in this way, and then apply a light to it, the heat cannot penetrate so instantaneously into the small spaces existing between the fibres of the cotton, as it would if applied to the loose carded gun-cotton. You observe the great difference in the rapidity with which the gun-cotton in the two conditions burns. Therefore, this is manifestly a simple and effective method of modifying the explosive action of the material; and it is upon this simple modification of the mechanical condition of gun-cotton, that all the improvements effected in its application by General von Lenk, in Austria, depend. Instead of employing cotton-

wool in a carded condition, for conversion into gun-cotton, it is used in a loosely spun form; being converted into roving or yarn of different sizes, regulated by the purposes to which it has to be applied. Here is a large hank of gun-cotton, the cotton-wool having been, before the treatment with acids, converted into this very loose form of yarn. Having the material once in this form, we are now enabled to let it burn comparatively speaking slowly, and with great regularity. You will readily believe, from the manner in which you perceive that this piece of gun-cotton burns, that it could be accurately timed to burn a given length per second in the open air. We have here a finer description of gun-cotton yarn, and if I inflame a portion of it, you will perceive that it is a quicker burning material than the coarser and more open yarn.

The gun-cotton in this form of twisted yarn, is presented to us in a condition in which it can be converted into a variety of forms, suitable for different purposes. If we want to employ it in cannon, where it is to exert its explosive force gradually, the coarse yarn is rolled or twisted with moderate tightness round a reel or hollow cylinder of wood, the size of which is determined by that of the chamber of the gun and by the weight of the charge to be used; the best result being obtained by so arranging the latter that the cartridge entirely fills the space allotted to the charge in the gun. Similarly, small-arm cartridges are made of cylindrical plaits of fine yarn or thread, which are fitted compactly in layers, one over the other, upon a small cylinder or spindle of wood. In both of these arrangements the combustion of the charge can proceed only from the external surfaces towards the interior of the cartridge. On the other hand, the charges for shells, in which the most rapid explosion is most effective, and the priming for quick matches, which are intended for firing several charges simultaneously, and almost immediately upon the application of flame, consist of cylindrical, hollow, and moderately compact braids (similar to lamp-wicks) made of gun-cotton thread, or very fine yarn.

I will show you how rapidly the gun-cotton burns when in the plaited form, which is that employed for quick match, in shells, and for small-arm cartridges. You observe this large mass of gun-cotton is almost instantaneously converted into gaseous matter, with explosive violence. Here we have a similar plait confined in a waterproof case, in which form it is used as a quick match for mining purposes. Its combustion takes place so rapidly, that small portions are scattered without being burnt. This circumstance, by the way, constitutes one of the objections to gun-cotton, and requires to be very carefully inquired into, for the purpose of ascertaining whether the scattering of small particles by an explosion in this manner may not be a serious cause of accident in mining operations.

I will give you a striking illustration of the difference in the rapidity with which gun-cotton may be made to burn. If we take the material in the form of a tight cord, without any perforation at all, and if we introduce the cord into a case of paper, glass, or any other material, into which it fits tightly, we can make the gun-cotton burn so slowly

that it almost appears to smoulder. It is, in fact, converted in this manner into a material adapted for fuzes. By thus simply allowing the cotton to burn only at one particular point, it burns with a very great degree of slowness and regularity. I have here a small fuze made in a glass case, so that what takes place in the interior may be readily seen. I will apply a light to one end of it. You see it burns very slowly; it is only smouldering inside the tube. There is a jet of inflammable gas burning at the opening of the fuze, just as in the case of a gunpowder fuze. Thus, you perceive, we may readily employ gun-cotton for the manufacture of fuzes, if it should offer any advantages in that direction. This experiment affords a remarkable contrast to the rapidity with which the gun-cotton burned just now when in the form of plait. But I can make it burn even more rapidly than it did in the latter form, simply by modifying very slightly its mechanical condition in the interior of the tube. If, instead of using it in the form of a tightly twisted cord, fitting tightly in the tube, we insert loosely into the tube two or three pieces of the coarse yarn, placed side by side, upon applying heat to the gun-cotton thus arranged, we perceive that the explosion of the entire mass takes place instantaneously, and the result of that instantaneous explosion is the shattering of the tube into innumerable minute fragments. We see, therefore, that gun-cotton is susceptible of very great variation in its mechanical arrangement, and consequently in the rapidity with which it burns.

I should now like to investigate experimentally a few of the phenomena attending the combustion of gun-cotton under different circumstances, because they serve to throw considerable light upon the different effects which the material exerts as an explosive agent, as shown by the experiments which we have just instituted.

In speaking just now of the general properties of gun-cotton, I omitted to show you that, when it is exploded in the ordinary manner in open air, it furnishes a large body of flame, and a mixture of gases and vapour, exhibiting acid properties. The production of acid vapour by the ignition of gun-cotton, has always been regarded as one very great objection against its employment as a propelling agent in arms of any description. One of the gaseous products obtained by burning gun-cotton in the open air is exceedingly corrosive; it acts on metals very powerfully indeed. If I introduce into the vessel in which I have burned gun-cotton, a small quantity of paper dyed with a vegetable blue, that blue will very speedily become red, in consequence of the acid nature of one of the products. Another result observed when gun-cotton is burned in an open vessel is, that the first flash produced by its combustion is followed by a pale bluish flickering flame, lasting for a second or two. That flame is due to the burning in the air of inflammable gas evolved by the explosion of the gun-cotton.

If we exclude air from gun-cotton, and then inflame it, the combustion of the material will appear very different, simply because there is no air present to furnish the oxygen necessary for the burning of the inflammable gas evolved. I will just compare the effect of burning gun-cotton in air, and in a vessel containing another gas in place of air, in order to show you that this large flash of flame, when gun-cotton is burned in air,

has nothing whatever to do with the actual burning of the substance itself. Here we have the gun-cotton in two vessels; one is open at the top, communicating with the air, and is filled with ordinary air. I ask you to notice once more the large body of flame, in addition to the first flash. Here we have another vessel filled with carbonic acid gas; we have therefore excluded air, and you observe what appears to be a different kind of combustion. Again, if I burn gun-cotton in a closed vessel which originally contained air, but from which I have exhausted the latter by means of an air-pump, the gases evolved by the gun-cotton when it is inflamed by voltaic agency, are prevented from burning, because oxygen has been practically removed from the apparatus. Moreover, the gun-cotton burns very slowly indeed, because the atmosphere in the vessel is so very highly rarefied, that the gases expand enormously as they are evolved, and abstract the heat necessary for rapid combustion, as they escape from the gun-cotton. You perceive when heat is applied to the gun-cotton in this exhausted globe, we have no flash of flame, and the gun-cotton burns very slowly, appearing only to smoulder. This is, as I have said, simply because those gases generated by the decomposition of gun-cotton—not burned, but generated very slowly indeed—expand into the rarefied space, and carry away the heat which we are applying to the gun-cotton, as well as the heat developed by the combustion of the latter.

It will be readily conceived that the mechanical state of the gun-cotton (*i.e.*, the particular form in which it is employed) will greatly influence the nature of phenomena observed, when this substance is ignited in air, or in various gases, either at ordinary or diminished pressures. We have seen that when a tuft of carded gun-cotton is ignited in carbonic acid (and I might have employed carbonic oxide, nitrogen, coal-gas, hydrogen, and other gases), it burns only with a pale yellow flame; this flame, when furnished by equal quantities of gun-cotton, is much smaller in an atmosphere of hydrogen than it is, for example, in carbonic acid; a fact which must be ascribed to the comparatively very rapid diffusion of the generated gases when hydrogen is used. In operating with pieces of gun-cotton yarn, instead of employing loose tufts, the material, when ignited by a red-hot wire in atmospheres of carbonic acid, nitrogen or carbonic oxide, burns much more slowly than it does in air under the same conditions; and its combustion is accompanied only by a very small jet or pointed tongue of pale flame, which is thrown out in a line with the burning extremities of the piece of yarn. In the same way, if the yarn is enclosed in a tube or other vessel, through which those gases are circulating, and from which one extremity of the gun-cotton protrudes, when the latter is lighted it will burn in the ordinary manner only until it reaches the opening of the tube, when the form of combustion will at once be changed to that just described. If, however, corresponding experiments are made in atmospheres of hydrogen or coal-gas, the gun-cotton yarn will burn in the slow manner described, but only for a very brief period; indeed, it ceases to burn at all almost instantaneously. This result is not due to the high diffusive powers

of the gas in which the gun-cotton is burned, as it may be obtained equally in open and in perfectly closed vessels; it can therefore only be ascribed to the high cooling powers, by convection, of the gases employed. Pure nitrogen is one of the gases which allows gun-cotton yarn to burn in the slow manner, but if mixed with one-fourth its volume of hydrogen, it arrests the combustion of the material, just like coal-gas or pure hydrogen.

A rapid current of air will also effect the transformation of the combustion of gun-cotton from the ordinary to the slow form, if the yarn be enclosed in a moderately wide glass tube, with one end protruding from the tube, so that it may be inflamed in the ordinary manner; but, unless the current be very rapid, an explosive mixture of air and the inflammable gases generated from the gun-cotton may be produced in the tube, and become ignited, in which case the gun-cotton will flash into flame instantaneously, and the tube will be shattered by the explosion. If, however, I pass a long piece of thin gun-cotton yarn through this small narrow glass tube, which is about two inches long, into which it fits so loosely that it may be drawn through very easily, upon lighting it in the ordinary manner at one end, you will find that when the flame reaches the tube through which the yarn is passed, its character will change at once; it will burn in the slow manner in the tube; and when the combustion reaches the other side, the gun-cotton actually continues to burn, with the small tongue of pale flame, in the air, just as it did when I took such precautions to exclude the air. I may produce this change from the quick to the slow combustion even more simply. By perforating a card, and passing a piece of gun-cotton through the small perforation, in which it fits loosely, you will find that I can make the gun-cotton pass from one form of combustion to the other with the greatest ease; for as soon as the ordinary large flame of burning gun-cotton reaches the perforation, it is transformed into the small tongue of pale flame.

The cause of these phenomena is extremely simple; and these curious results will very likely throw considerable light on the various effects produced by the explosion of gun-cotton under different circumstances. The gun-cotton, when it is employed in the form of this thin yarn, which is laid upon a flat surface and inflamed, burns only at the one point where the heat or flame is applied. But the gases that are evolved produce a large flame by burning in the air; this flame surrounds the portions of gun-cotton which are next to be burned, and heats them to the temperature necessary for their rapid combustion. But if I prevent those gases, even for an instant, from enveloping the portions of the gun-cotton in immediate proximity to those which are burning; in other words, if I force them to escape, for a moment, only in one direction, namely, in a direct line with the burning surface of gun-cotton from which they are emitted, the latter is no longer *continuously* heated to the temperature necessary for its rapid and more complete combustion, and hence the gases themselves are in turn not supplied with sufficient heat for their ignition. Now, as the gases which escape unburned convey away a very large portion of the heat developed by the metamorphosis of the gun-cotton, it is impossible for the latter to

continue to burn otherwise than in the slow and imperfect manner. If, however, I hold a flame or highly-heated body in the path of the gases as they escape, they will at once be ignited, and the yarn will burst into the ordinary form of combustion. The correctness of this explanation may readily be demonstrated by two or three simple experiments. Thus, if a piece of loose or open gun-cotton yarn is employed, in place of the compact material which furnishes these results just described, it is very difficult, or even impossible, to cause the rapid combustion to pass over into the slow form, because the escaping gases cannot be diverted all into one direction, and cannot, therefore, be prevented from transmitting the heat necessary for perfect combustion from particle to particle of the material. Again, if I place a piece of the compactly twisted gun-cotton yarn, upon a flat surface, inflame it in the usual manner, and then direct a jet of air, by means of this glass tube, in a line with the gun-cotton, so as to meet the flame, the latter appears to be blown out, though the cotton still burns; in fact, the burning gases are prevented for an instant from completely enveloping the extremity of the gun-cotton, and hence the combustion at once passes from the quick to the slow form.

Now if, while the yarn is burning in this slow manner, I direct a very gentle current of air *against* the burning portion, so as to force back upon it the gases which are escaping, and thus impede the rapid abstraction of heat, the gun-cotton soon bursts again into the ordinary form of combustion, because, under these circumstances, the gases are almost immediately raised to the temperature necessary for their combustion. And here is one more experiment of this kind. I place a piece of the yarn upon a board, make it burn in the slow manner, and then raise one end of the board gradually, so that the burning extremity of the gun-cotton is the lowest; the latter bursts into flame as soon as the board has been raised to a position nearly vertical, so that the escaping gases flow back upon the burning surface.

I have still to show you that I can produce the slow or imperfect form of combustion of gun-cotton in open air, by applying to any part of a piece of the thin compact yarn a source of heat not sufficiently great to inflame the gases generated. A wire or metal rod, heated to any temperature between 280° F. to just below visible redness, or the spark of a thin piece of smouldering string, will invariably produce the result described. Of course, this effect, like most of the phenomena described, is to a considerable extent dependent upon the mechanical condition of the gun-cotton, and upon the relation between the *quantity* as well as the *degree* of heat applied, the amount of surface of the gun-cotton, and other conditions. While a small spark, or a thin platinum wire heated to full redness, only induces slow combustion in the compact gun-cotton yarn, a thick rod of iron, heated only to dull redness, will invariably inflame it in the ordinary manner. A piece of open yarn cannot be ignited so as to burn in the slow manner; on the other hand, the more compactly the gun-cotton is twisted, the more superficial is the slow form of combustion induced in it; indeed, the gun-cotton may be rendered so compact that it will simply smoulder in open air if ignited as described, leaving a considerable carbonaceous

residue; and the heat resulting from this most imperfect combustion will sometimes be abstracted by the escaping gases more rapidly than it is developed, so that the gun-cotton will then actually cease to burn, even in open air, after a short time.

The remarkable facility with which the effect of heat upon gun-cotton may be modified, so as even to produce results totally opposite in their characters, as exemplified by some of the experiments which have been exhibited, renders it easily conceivable that this material may be made to produce the most varied mechanical effects, when applied to practical purposes; that it may, indeed, be so applied as, on the one hand, to develope a force very gradual in its action, which may be directed and controlled at least as readily as that obtained by the explosion of gunpowder, while on the other hand, it may be made to exert a violence of action and a destructive effect far surpassing those of which gunpowder is susceptible. The results arrived at in Austria, which show that gun-cotton can be made to produce effects from three to eight times greater than those of gunpowder, cease to be surprising after a study of the chemical and physical characteristics of this interesting explosive agent.

I should like to say a few words with regard to the nature of the products of combustion of gun-cotton, this being a branch of the subject of very considerable importance.

There is no doubt that the products of combustion of gun-cotton vary in their nature almost as greatly as the phenomena which attend the exposure of the material to heat under different circumstances. We have seen that, when gun-cotton is inflamed in the open air, there is produced (in addition to water, carbonic oxide, carbonic acid, and nitrogen), a considerable proportion of the gas known as binoxide of nitrogen, which assumes a red-brown tinge, and becomes very acid when it mixes with air. The products of the different forms of imperfect combustion which gun-cotton has been described as susceptible of undergoing, are undoubtedly much more complex in their character than those just referred to. They include at times a proportion of some substances, not yet examined, which make their appearance as a white vapour or smoke; cyanogen can readily be detected in all the products of imperfect combustion; the proportion of binoxide of nitrogen is generally so large that the gaseous product becomes very highly coloured when mixed with air; peroxide of nitrogen has also been observed in some instances; lastly, there is little doubt that the products occasionally include a proportion of oxidising gases (probably oxygen.)

The products which have just been spoken of are the results either of the decomposition of gun-cotton, in air under ordinary conditions, or of its imperfect combustion under various circumstances. But when the explosion of material is effected in a confined space, in such a manner that the main decomposition takes place under pressure, the metamorphosis which the material undergoes is of a more simple and complete character.

It has been found by Karolyi that, when gun-cotton is exploded by voltaic agency in a shell which is burst by the explosion, and which is

enclosed within an exhausted chamber so that the products of decomposition are collected without danger, the results obtained under these conditions are comparatively simple; the analysis of the contents of the chamber, after the explosion, showed that they consisted of carbonic acid 20·82 per cent., carbonic oxide 28·95, nitrogen 12·67, hydrogen 3·16, marsh gas 7·24, water 25·34, and carbon 1·82 p.c.

I will try to produce before you the results of the most perfect decomposition of gun-cotton. In this stout iron sphere a small shell containing gun-cotton is enclosed, which I will explode; but, in order to do it safely, I will exhaust the air from the large sphere, and this will enable me to collect the gases produced by the explosion of the shell within. If I burst the shell, we shall know it by the production of a slight sound in the interior of the vessel. The shell is now exploded, and I allow the gases to escape through this tube. You see that they burn with a pure blue flame, indicating that the carbonic oxide produced is not mixed with binoxide of nitrogen, which gave it the green tinge in our former experiments on the explosion of gun-cotton. You shall also see that we have no acid in the gaseous mixture. I will just allow the gas to impinge for a short time upon this piece of blue paper. You may take it for granted that a long continuance of this application will produce no appreciable change upon the appearance of the paper. Lastly, if I pass the gas through a solution of salt of iron, you will see that it will produce no discolouration, while if I shake up some of the same solution with gases produced by burning gun-cotton in air, it rapidly becomes of a dark brown colour. Thus we see that, although when we explode gun-cotton in air we produce nitric oxide vapours (which become acid when they mix with air), when we explode the material under pressure, as it is exploded in practice, these acids are not produced in any appreciable quantity. It is evident, therefore, that, just as the decomposition of this material is of a more complicated and intermediate character, when its combustion is rendered imperfect by diminution of pressure or other circumstances, so, conversely, the change which it undergoes will be the more simple, and its conversion into gaseous products the more complete, the greater the pressure, beyond normal limits, under which it is exploded, that is to say, the greater the resistance offered to the generated gases upon the first ignition of a charge of gun-cotton (and consequently the higher the temperature at which the decomposition of the confined gun-cotton is effected). The notions hitherto generally entertained with regard to the very noxious character of the products of explosion of gun-cotton and their powerfully corrosive action upon metals—notions which were based upon the effects observed on exploding gun-cotton in the open air—have unquestionably been already proved to be erroneous by the results of actual application of gun-cotton to artillery, and other purposes.

There are two very important points of difference between the products of the decomposition of gunpowder and those formed on the explosion of gun-cotton. In the first place there is, practically speaking, no water produced by the explosion of gunpowder, while, in the case of gun-cotton, that substance constitutes no less than about 25

per cent. of the total products of metamorphosis. It can hardly be questioned that this water exerts functions of the highest importance in the application of gun-cotton as an explosive agent. The proportion of permanent gas furnished by a given volume of gun-cotton, in a very compact condition, is considerably less than that produced from an equal volume of gunpowder, but this difference must be far more than counterbalanced by the large volume of highly elastic vapour furnished, at the moment of the explosion, by the water formed. In fact, the heat generated by the chemical change which the gun-cotton undergoes enables the water to act as a permanent gas. Moreover, the circumstance that fire-arms, in which gun-cotton is employed do not become heated by repeated firing to anything approaching the extent observed when gunpowder is employed, must be ascribed, at any rate in great part, to the fact that the heat is principally expended, immediately upon its development, in the conversion of the water into vapour of high tension. If you recall to mind the comparatively low temperature at which gun-cotton explodes, you will realise the great importance of the fact that the fire-arm does not become heated by repeated firing with gun-cotton to anything approaching the extent observed when gunpowder is used.

The second and equally important difference between the results of metamorphosis of gun-cotton and of gunpowder is to be found in the fact that the former is completely transformed into substances which are either permanent gases, or which exist as gases or vapours at the moment of explosion. No solid residue nor smoke is produced by the explosion of gun-cotton. The serious inconveniences attending the employment of gunpowder, which arise from the fouling of fire-arms and from the dense smoke produced upon their discharge, would be altogether set aside by the substitution of gun-cotton for that material. It is asserted that there are circumstances under which the smoke produced upon firing guns, offers advantages in warfare. I will not pretend to discuss this point, but I feel sure you will admit that, in casemates, or between decks on board ship, in a naval action, it would be one of the greatest boons which could be conferred upon the soldier or sailor, if the dense, stifling, and enshrouding smoke of powder could be abolished.

The proportion of solid matter produced upon the explosion of gunpowder has been fixed at very different amounts by different authorities. According to the views of the decomposition of gunpowder which were generally accepted, until recently, war-powder of average composition, was considered to furnish from 40 to 50 per cent. of its weight of matter, *solid at ordinary temperatures*. The earlier investigators (Gay-Lussac, Chevreul, &c.) of the decomposition of gunpowder, who fixed the solid products at that amount, represented the results of the explosion of this material as being of a very simple character, and in harmony with the theory that gunpowder is converted essentially, by its explosion, into carbonic acid (or a mixture of that gas and carbonic oxide), nitrogen, and sulphide of potassium. But more recent experimentors, Bunsen and Schischkoff, who have made a very elaborate examination of the products which they

obtained by the explosion of gunpowder, represent the change to be one of a very complicated character; fix the percentage of solid substances found at from 68 to 70 per cent. of the gunpowder used, and show that the sulphide of potassium, which has been considered as the principal of these products, was only formed in very small proportion in their experiments. The conditions under which these chemists exploded the gunpowder did not, however, correspond at all in their character to those under which gunpowder is exploded in actual practice, and would, therefore, be very likely to furnish results greatly at variance with those produced when a charge of powder is fired in a gun, a shell, or a mine. That sulphide of potassium is abundantly produced upon the discharge of a fire-arm appears beyond doubt; it may be readily detected in the solid matter which remains in the barrel near the breech; it may be found deposited in considerable quantity near the muzzle of the arm, and there appears strong reason for believing that the flash of flame, observed at the mouth of a fire-arm upon its discharge, is due in part to the ignition, as it comes into contact with the air, of sulphide of potassium, which has been *vaporised* by the heat of the explosion, and is thus mixed with the escaping gases. It is well known that a red heat is sufficient to convert sulphide of potassium into vapour, and the heat resulting from the explosion of gunpowder is far above that temperature; it is, therefore, not yet proved that a considerable proportion of the products of the decomposition of gunpowder, though solid at ordinary temperatures, does not exist in the form of perfect vapour at the moment of the explosion in a fire-arm, just as the water produced from gun-cotton, though liquid at ordinary temperatures, exists as a vapour at the moment of the explosion. Mr. Scott Russell, in his interesting lecture at the Royal Institution, pronounced the 40 or 68 per cent. of solid matter produced from gunpowder to be so much "filthy rubbish," but I am confident you will concur with me, after what I have said on this subject, in thinking that this wholesale condemnation is somewhat premature; that it is necessary we should possess more definite information than now exists with regard to the nature of the products furnished by charges of gunpowder at the moment of explosion, under circumstances assimilating to those of its actual employment, before the fairness of the argument can be admitted, that certain products of the decomposition of gunpowder must be regarded entirely as waste matter, simply because they are *solid at ordinary temperatures.*

There is one more subject upon which I ought to say a few words. It is stated, upon the authority of the military committees who, in Austria, have experimented upon the application of gun-cotton to artillery purposes, that the recoil of a gun is considerably less with gun-cotton than when gunpowder is used. That such should be the case when the two explosive agents are applied to produce equal effects, (*i.e.*, to furnish equal ranges) is readily intelligible, as the weight of material used as the charge is, in the case of gun-cotton, only about one-third of that of the gunpowder employed. But, it is also stated that, in using equal weights of the two materials, the recoil of the gun is greater with gunpowder than with gun-cotton. It is impossible, in the

present state of our knowledge, to venture upon an explanation of such a fact. Mr. Scott Russell has put forward with great confidence a reason why gunpowder must produce the greater recoil. If I understand him rightly, he considers the increased reaction upon the gun to be due to the great resistance offered by, or the work done upon, the *solid* products formed on the explosion of gunpowder, which have to be projected from the gun, just as the shot or shell is. This explanation is not satisfactory to many besides myself, and an ingenious experiment which he exhibited to us a short time ago, at the Royal Institution, to demonstrate the difference in the recoil produced by the two agents, though it was very striking, as far as Mr. Scott Russell carried it out, shows, when pursued somewhat further, that this subject cannot be quite so simply and readily disposed of as he would lead us to believe. Equal weights of ordinary gunpowder and of gun-cotton in the form of coarse yarn, were successively placed in one scale of a balance, of which the other scale was loaded with a greater weight than that of the explosive. Upon igniting the gunpowder, the scale-pan which contained it was violently depressed, to such an extent as completely to raise the other over-weighted scale-pan; but, when an equal weight of gun-cotton was exploded under the same circumstances, the weighted scale-pan was hardly sensibly raised. I will perform this experiment before you with this pair of scales. The long arm or indicator of card-board, which projects in a line with the beam, from that end to which the weighted scale-pan is suspended, will, by travelling up this vertical index, enable those at a distance to observe any slight depression of the scale-pan in which the explosive is burned. Now, I will explode, successively, equal weights of ordinary gunpowder and of coarse gun-cotton yarn in the scale-pan, and you will observe the results which I have already described. But I will now ignite in the pan an equal weight of gun-cotton made up in the form of a hollow braid, and you will observe that the pan is depressed to a considerable extent; in fact the force exerted upon the loaded scale-pan was, as you saw, not very inferior to that developed by the gunpowder. Now, let me again take some of the same gunpowder used in the first experiment: I will reduce it from the granular to the pulverulent condition by crushing it with this pestle and mortar, and I will now explode in the scale-pan an amount of this equal to the gunpowder and gun-cotton already used. You perceive that, this time, the balance hardly moves; you could scarcely perceive any difference whatever between this effect and that produced, in the first instance, with gun-cotton. Just one more experiment. Here is the explosive known as fulminate of mercury, which, on the instant of its ignition, furnishes simply gases and vapour of mercury, just as gun-cotton furnishes gases and vapour of water. I will explode in the scale-pan an amount of this substance equal to only one-half the weight of the gunpowder and gun-cotton used. You will observe that the scale-pan is far more violently depressed in this instance, where we are using an explosive which furnishes no solid products, than it was when we employed double the weight of granulated gunpowder. I must refrain at this late hour from offering

any explanation of these different results; indeed, I have only made those experiments for the purpose of showing you that there are evidently other circumstances, apart from the formation of solid products, to which we must look for an explanation of what appears to be a difference in the recoil, or reaction produced by different explosives.

And now I must conclude this imperfect outline of the history of gun-cotton from its discovery to the present day. There are several other points of considerable importance included in our present knowledge of this interesting and remarkable substance, to which, had time permitted, I would have much liked to refer, but I feel that I have already trespassed too much upon your patience. I think, however, it has been made evident to you that, although gun-cotton has been known to us since 1846, we are only now really becoming acquainted with its properties and its true nature as an explosive agent.

It will, I believe, be generally conceded that gun-cotton, as it may now be manufactured, possesses several most important advantages over gunpowder. The great control which may be exercised over its explosive action; its property of exploding without producing either smoke or residue, and the safety of its manufacture, are unquestionably attributes of the very highest value in a material of the class to which gun-cotton belongs, and may combine to fulfil the expectations of its most sanguine friends. But it is imperative that we should not lose sight of the fact that, unless the stability of gun-cotton is proved by the most searching investigations to be beyond doubt, not all the advantages which are claimed for it, in addition to those which it has been proved to possess, would warrant its substitution for gunpowder in naval, military, or engineering operations.

The CHAIRMAN: I am sure I only express the opinion of all present when I say we have had a most interesting lecture. Not only is the subject itself very interesting, but the manner in which the lecture has been delivered, and in which the experiments have been performed, has added very much to the pleasure of the meeting. I may say that I once asked an eminent lecturer and professor in London, what made his experiments so very attractive. He said he always took care now and then to fail a little, because it added very much to the interest of the experiments. If experiments were always successful, he said, people would expect them to succeed as a matter of course, and they would lose half their attractions. I can only add to this, that from what we have heard to-day, it is clear that there is yet a great deal to be learned upon the subject of gun-cotton. Therefore, I shall look forward at some future time to another interesting lecture upon the same subject, when science has made further advances in this direction.

NOTE.—Since the delivery of the above lecture, some progress has been made in experiments instituted by me for the committee on gun-cotton, for the purpose of examining into the conditions which may affect the stability of that substance. Several French chemists of eminence have also recently been occupied with this subject, and two communications, embodying the conclusions arrived at by them, have

been made within a few weeks to the Academy of France. One of these is in the form of an official report, prepared by MM. Pélouze and Maurey, who had been entrusted by the French Government with the study of gun-cotton as prepared by von Lenk; the other is an account of the results obtained by M. de Lucca, on exposure of gun-cotton to heat, under various conditions.

The conclusion to which these chemists have been led by the results of their experiments is, that gun-cotton is not applicable as a substitute for gunpowder, on account of its being so susceptible to change as to render it liable to spontaneous ignition.

The results arrived at, up to the present time, in this country, both with Austrian gun-cotton and with material prepared in England at different establishments, according to the Austrian system, differ in several most important respects from those described in the memoirs of the French chemists. The investigation of the effects of heat, light, and of storage, under a variety of conditions upon gun-cotton, must necessarily extend over a very considerable period of time, but the data already obtained indicate decisively that the unfavourable results arrived at by the French chemists, in a comparatively short space of time, cannot be accepted as conclusively establishing such a want of permanence in gun-cotton as to preclude its application as an explosive agent.

October, 1864. F. A. A.

Evening Meeting.

Monday, May 30th, 1864.

ADMIRAL SIR GEORGE R. SARTORIUS, Kt., in the Chair.

NAMES of MEMBERS who joined the Institution between 16th and 30th May, 1864.

ANNUAL.

Brown, Frdk., Lieut. 3rd Roy. Sur. Mil., 1*l.*
Griffith, J. G. T., Capt. Royal Engrs., 1*l.*
Parry, F. W. B. S., Lieut. 22nd Regt., 1*l.*
Douglas, Sholto, Commander R.N., 1*l.*
Haslett, A. K., Lieut. Royal Engineers, 1*l.*
Kelly, J. L., Lieut. 10th Regt., 1*l.*
Magrath, J. R., Capt. R.A., 1*l.*
Trivett, J. F., Lieut. R.N.R., 1*l.*
Brown, J. H., Lieut. R.N.R., 1*l.*
Harwood, J. A. P. K., Lieut. 13th Lt. Inf., 1*l.*
Macliver, D., Lieut. 2nd Som. Mil., 1*l.*
Gibb, P. M. N., Lieut. 13th Lt. Inf., 1*l.*
Patton, H. C., Capt. 22nd Regt.
Hamersley, Jas., Lieut. 22nd Regt.
De-Cetto, M. H. E., Ens. 72nd Highlnrs.
Green, Edwd., Maj.-Gen. Bom. Staff Corps.
Anderson, Arthur, M.D., Inspector-Gen. of Hospitals, 1*l.*
Lethbridge, C., Col. H.M. Madras Army.

A PROPOSED PLAN FOR WORKING THE HEAVIEST ORDNANCE ON BOARD ARMOUR-PLATED SHIPS AND IN FORTIFICATIONS, WITH COMPLETE PROTECTION FOR THE MEN.

By Captain E. A. INGLEFIELD, R.N., F.R.S.

MR. CHAIRMAN, LADIES and GENTLEMEN,—To propose a revolution in the form of our ships of war and the method of fighting guns both at sea and on land batteries, may at first sight appear a presumption which could only be qualified by evidence of some plan more feasible, of some arrangement more comprehensive, and of advantages which will compensate for such material changes.

Now, Sir, though I cannot lay claim to the discovery or invention of such a plan, yet I have this evening undertaken to lay before your Institution two models, which purpose to combine certain novel ar-

rangements, by which guns of the heaviest description known, may be fought on board ships and on land fortifications, with complete protection for the gunners, and only a partial and temporary exposure of the gun. Of course it will be understood that in making this assertion, it is clearly with the provision that our armour plates are impenetrable, and that the walls of a fortress resist the impact of shot. These are elements of resistance which it is not part of my business to discuss this evening, though I may remark in passing, that it is not an unusual expression amongst naval men to speak of the "Warrior" as being practically impenetrable, though experiments again and again renewed, have gone to show that this far-famed vessel does not possess an armour-plated side capable of resisting the shot or even shell projected by the new experimental guns. I have, therefore, had this matter under consideration in the preparation of my plans for this new method of fighting heavy ordnance. I have endeavoured to combine an extra protection for the crew, with a certain degree of utility for the purposes of lifting the gun, and I shall presently explain to you the method by which I obtain these results.

But before entering into an explanation of the models before you on the table, it would perhaps be better to state for the information of those amongst my audience who may not be fully aware of the present position of our iron-clad navy, what are the accepted forms and build of our ships of the present day as regards their actual outline and their shot-resisting capabilities. I shall then be able more readily to explain the position which I have taken, the short-comings which I have proposed to meet, and the general advantages of a novel system for fighting guns of the largest calibre at sea and on shore.

First, exploding altogether from the category, ships of the old wooden class, I must commence with those of the "Warrior" description—vessels protected on their gun-deck and below the water-line by armour plates of a thickness considered practically sufficient to keep out the shell and shot of the ordinary sea service guns—at moderate ranges—and this armour-plate protection, with its necessary backing, in the "Warrior," actually amounts to 1,300 tons of dead weight on her outer sides; her tonnage being over 6,000.

The thickness of these plates varies in different vessels from $4\frac{1}{2}$ to $5\frac{1}{2}$ inches, and in the case of the "Black Prince," extends $5\frac{1}{2}$ feet below the water line. Now, vessels of these huge dimensions are only constructed to carry from 30 to 40 guns, and these guns are mounted at broadside ports, reduced now to the smallest dimensions consistent with the proper working of the gun at extreme training.

In the model before you is a port made to the scale of $\frac{3}{4}$ of an inch to a foot, and indicates the exact size and proper proportions of the ports of the iron-plated ram frigate "Agincourt," now building at Messrs. Laird's yard at Birkenhead. By actual measurement and tracings obtained on the premises, these ports are 3 feet $7\frac{1}{4}$ inches in depth by 2 feet breadth on the outer side, but 3 feet 9 inches on the inner side, and they are placed 11 feet 8 apart. I am exact in stating this, as I wish to point out very particularly the area equivalent to a space 10 feet square (in a vessel having only 15 ports on a broadside),

exposed to the unobstructed intrusion of shot and shell from an enemy's ship. And when we remember the lamentable destruction of life lately recorded in the sea fight between the German and Danish ships off Heligoland, when 14 men were killed and wounded at one gun, by a single projectile, he, then, who can say that any invention which shall go towards reducing these apertures in armour-plated ships, or, still better, shut them up altogether, is not a step in the right direction, can hardly realize the frightful carnage which must be the result of a sea fight in modern days though hardly lasting half the time occupied by our ships at Camperdown, the Nile, and Trafalgar; out of which fights they escaped comparatively scathless.

Naval men have not two opinions on this subject, and hence the eager anxiety expressed amongst them as to the success of this or that gun and its projectile.

I have spoken now of what may be called the first Government form of armour-plated frigate. There are other varieties, and these are usually alluded to as vessels of the "Defence" class, or the "Hector" class, &c. It will be sufficient to add that in this latter-named vessel of 4,089 tons, the weight of armour-plates is limited to 873 tons against 1,300 tons in the "Warrior," and these tapering round the stem and stern, are $4\frac{1}{2}$ inches in thickness at the broadsides.

There is still another class of iron-plated frigates to which I must make some allusion, as they appear to be gaining golden opinions for themselves from the result of their first experiments—I speak of Mr. Reed's vessels. Until that gentleman became chief-constructor of the Navy, it was deemed an impossibility to combine great speed, heavy armaments, and impenetrable armour-plated sides with a moderate tonnage; but, by the experimental vessels "Research" and "Enterprise," Mr. Reed has proved the fallacy of this supposition, for he has combined all these requirements in vessels that are termed sloops. The "Enterprise" being only 933 tons burden.

Whether these vessels, with their central iron-cased batteries, will not cause a revolution in the opinions of our shipbuilders and ship fighters, seems to be no longer a question, and much credit is undoubtedly due, not only to Mr. Reed as the chief constructor of the navy, but also to the Admiralty, who, against much opposition, singled out this talented gentleman for so eminent a position.

I have now done with iron-cased port-holed frigates, and I come to the first innovation upon the orthodox form of a vessel of war, and the method of fighting her guns; but I can hardly pass at once to a brief description of the clever invention of my friend and old messmate, Captain Coles, without some allusion to the angulated sides for ships of war, proposed by Mr. Josiah Jones, of the firm of Jones & Quiggin, iron shipbuilders, Liverpool. With an amount of patriotism and zeal seldom equalled, this gentleman has expended from his private purse a sum expressed by thousands of pounds, merely to exhibit to the world the soundness of his theory, and it is but fair to say, that the experiments carried out by the Government upon the shot-resisting targets constructed by Mr. Jones were successful as regarded the object that gentleman had in view. In what other requirements they failed for

their application to ships of war I am not in a position to state; but, together with other naval officers, I am so strongly of opinion that this form of angulated side might prove of great value for our fleet of the future, that I have constructed one side of my model to represent a vessel with angulated sides, and I believe that the day is not far distant when such a form will attract for itself the attention it deserves, and which did not elude the careful consideration of our ancestors in olden times, when they donned the pigeon-breasted steel cuirass, from which a bullet or spear would glance off, and the force of a sword blow be destroyed.

The turret or shield ship of Captain Cowper Coles must now occupy for a few moments our attention.

It so happened that I was one of a committee selected by the late Lord Lyons, when he was commander-in-chief of the Black Sea fleet, to examine and report upon the first proposals of Captain Coles for a gun-raft. It is almost needless to add that we were unanimous in the opinion that the invention (even in its immature form) was valuable; and we accordingly recommended that the Captain should be permitted to proceed to England for the purpose of bringing his proposals before the Admiralty. This was in the year of grace 1855, and now in 1864 the first turret-ship has not long been launched by the Government, and naval men are looking forward anxiously to the report of her abilities as a shot-resisting vessel, and what appears to be equally important, as a sea-going trustworthy ship.

Captain Coles' matured form of turret or shield-ship consists mainly in having iron shot-proof towers, which are placed amidships, and from 20 to 25 feet diameter, and which work centrally on turn-tables below the water line.

The turrets or cupolas (as they are indifferently termed) have one ormore ports of a size sufficient to ensure the proper amount of elevation and depression as regards depth, and of width with reference to the size of the gun mounted. The guns are directed upon the object to be aimed at, by moving the whole turret (which has a ratchet work and pinions below) to the proper angle, the captain of the gun looking out through an aperture in the roof of the turret to determine this angle, and give the necessary orders to the crew working the levers. When the gun or guns are pointed, they are fired in the ordinary manner, and the turret is turned away, so as to carry the ports out of the line of fire whilst the gun or guns are being reloaded. This also is accomplished in the usual manner, whether the piece be a breech or muzzle loader.

The object of the shield ship is to reduce the danger to the gun and gunners by a reduction in the size of the port and otherwise, by moving these openings out of the line of fire. And here I am bound to say, that I believe the advantage gained is great, but next, it becomes my duty to examine *at what cost* it is obtained.

First, a cupola-ship must be almost rebuilt, if it is intended to convert a ship of ordinary construction into this class of vessel. Apertures must be cut through two decks of a diameter varying from 20 to 25 feet, and this is a very serious consideration in a vessel which has

Fig.
Section of a Shi

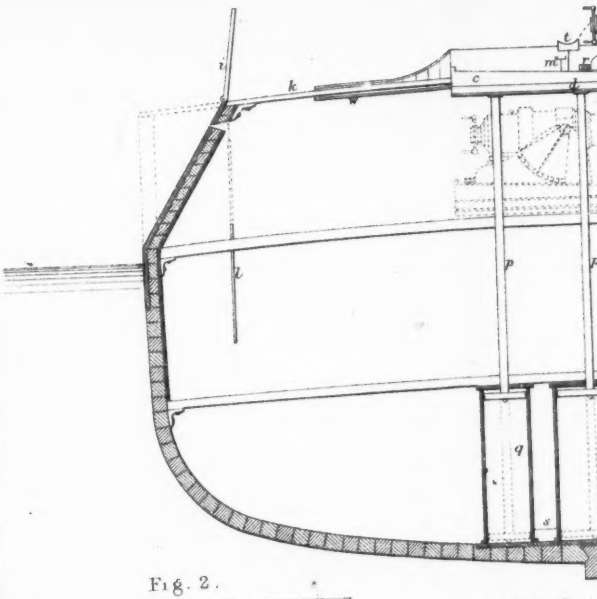


Fig. 2.

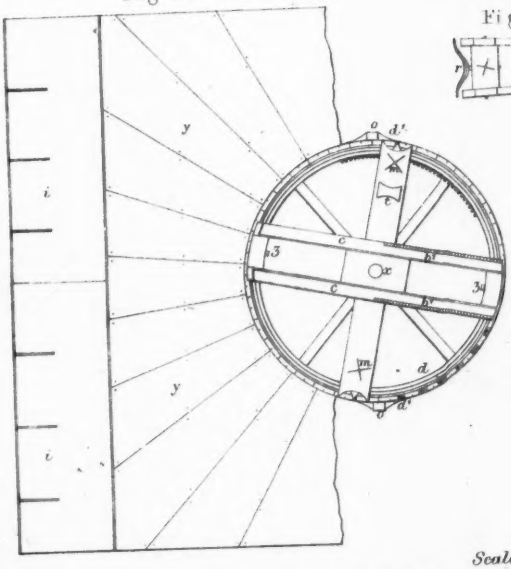
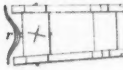


Fig. 3.



Scale 1/8 of

0 1 2 3 4 5 10

Fig. 1.
of a Ship of 1800 Tons.

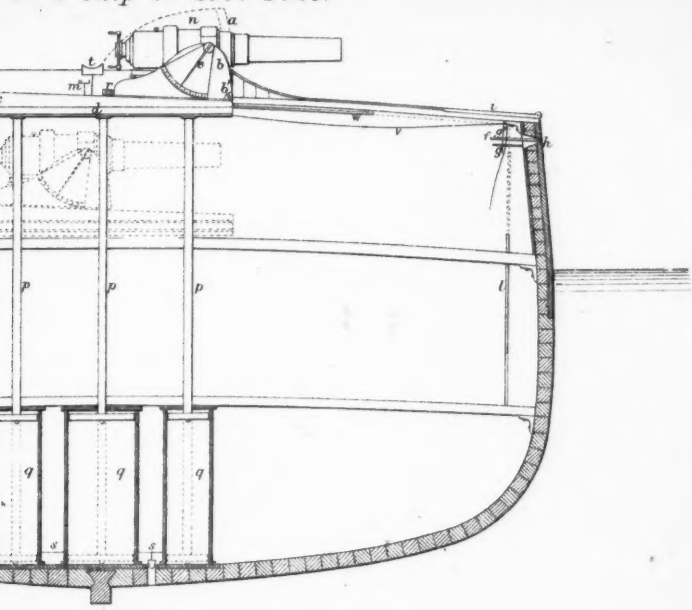


Fig. 3.

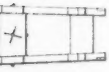
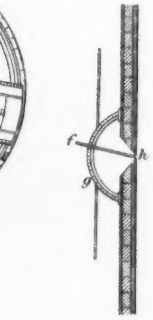


Fig. 4.



Reference.

a. The Gun
b. The Carriage
b'. The Pawle
c. The Slide
d. The Platform
d'. The Checks on D°
e. The elevating Pointer
f. The directing Tube
g. The directing Arc
g'. The elevating Arc
h. The orifice in the Ships side
i. The falling Bulwark
k. The recess for D°
l. The Counterpoise
m. The directing Levers
n. The cast iron Shield
o. The guide Stanchion
p. The Piston Rods
q. The Cylinders
r. The Spring on Gun Carriage
s. The steam Pipe and Valve
t. The Saddle
v. The Trigger line
w. The iron Shutters
x. The Axis for the Gun slide and Platform
y. The plated upper Deck
z. The Rollers for the Pendant and Tackle

ale 1/8 of an Inch to a Foot.

10 15 20 25 Feet

to bear upon her broadsides such an amount of armour plating as I have stated is borne by the "Warrior;" but to this we must add, the great weight of the iron cupolas, which I cannot better illustrate than by stating that in the far-famed iron-clad Birkenhead rams (which have been for several months under my charge), the turrets weighed each 100 tons without the guns, and this in vessels of only 1,800 tons burden. Thus it will be seen that, to obtain the partial protection of the crew fighting a turret-gun, we must cut large holes in the decks of our ships, and add an amount of top-hamper to the vessel, this, not the least objectionable element in such an arrangement for a sea-worthy vessel. It is just this which seems to be the most doubtful part as regards the success of the cupola-ships, for it must always be borne in mind that be the armament, or the means of fighting it, what it may, England's marine supremacy can only be maintained by possessing a sea-going fleet; and admirable as the cupola-ships may prove for coast defence, I cannot bring my 30 years' experience in the navy to reconcile the notion that a cupola-ship in a gale of wind will behave very differently to the Agamemnon, when she was well nigh foundering with the Atlantic cable on board.

Having now generally alluded to the present construction and form of our iron-clad navy, I bring you to the arguments which presented themselves to my mind when considering the *facts* I have laid before you.

I asked myself, cannot the advantages of cupola-ships over broadside port ships be obtained by some less cumbrous arrangement than such as is set forth in the first-named vessels?

And thus I was eventually led, after much anxious thought and some experiments and calculations, to propound the plans which I now propose to explain to you, with the assistance of the models on the table.

My invention consists—

Firstly, in an arrangement by which I can dispense with the necessity for ports through which to fire guns in an armour-plated ship.

Secondly. In a peculiar method of taking the aim or laying the piece, and of loading whilst the gunners are entirely protected; that is to say, as far as the capabilities of iron armour plates will admit, and in some degree still more effectually from the effects of a bursting shell, or splinters from shot which may have penetrated the sides.

Thirdly. I claim to employ a process for lifting the gun from its place of security to its firing position, by a power, I believe, hitherto unemployed for any practical purposes.

The model before you (see Plate XXVIII, Fig. 1) represents the section of a vessel of about 1,800 tons on the scale of three-fourths of an inch to a foot, and the gun which was pointing through the port cut in the side of the vessel is a perfect model of a 100-pounder Armstrong gun upon the same scale. I now close up this port, and in doing so may remark that I propose with comparative facility to convert any broadside port ships into a vessel fitted as I suggest, without any material re-arrangement of structure.

The gun is now mounted on a carriage and platform, specially

arranged for the purposes I propose, and this will be better described, by displacing the piece and exhibiting the parts separately.

The circular platform or turn-table (Fig. 2), upon which the inclined slide is made to revolve centrally, has an inner ratchet-work, the outer rim of which is graduated, and the inclined slide is provided with a flat transverse bar or plank which extends to the periphery of the platform, and carries at either extremity a pointer which marks the angle upon the graduated platform which the inclined slide is made to assume by means of pinions when moved by a lever, causing the whole slide to revolve round the turn-table.

The carriage and gun are mounted on the inclined slide in the usual manner, the slide being so situated, that on the firing of the gun, it recoils *up* the inclined plane, whilst for running out the piece preparatory to firing, its slope renders this operation more easy.

It will be seen that the metal ways on the gun-slide are provided with a pall-plate, whilst the carriage itself has palls fitted on its fore part, and a coach spring on its rear (Fig. 3). The gun carries metal pointers firmly fixed on the trunnions; these work in a recess prepared in the gun-carriage, and are the indicators of the angle at which the axis of the piece is laid, by reference to a graduated arc let into the recess, and thus, when the indicator stands at 0, the gun is laid on a plane with the deck of the vessel, or perfectly horizontal when the ship is on an even keel. The breech of the gun is elevated or depressed by the ordinary breech screw.

I have now explained the mode of directing the gun, when the angle to the keel of the ship at which the object lies has been ascertained, and I must now ask your attention whilst I describe this process.

Through the side of the vessel (Fig. 4), at a convenient height from the ship's deck, a small orifice, for the admission of a tube of the diameter of an ordinary spying-glass, is made and fitted on gimbles. This tube is free to move in any direction horizontally and vertically, within a necessary radius. Immediately beneath this tube, and hinged to the ship's side is a graduated arc, whilst vertically a graduated bifurcated bar receives the telescope, and works in a slot on the horizontal arc previously described. It will thus be seen, that the angle at which the object lies to the keel of the vessel may be readily observed, and it is not difficult to understand, that if this graduated arc and bifurcated bar, correspond with the graduations on the gun platform and the carriage, the axis of the gun may be easily adjusted to correspond almost mathematically with the axis of the directing tube, and I wish it to be particularly noted, that with such an arrangement, and under these circumstances, the gun may be pointed and loaded at the same time.

I come now to the process of lifting the gun to a spot from whence it may be fired, and here I must state, that several methods suggested themselves to my mind, viz., by steam, manual power, or hydraulics.

The beautiful precision with which the steam-hammer of Mr. Nasmyth works, and the marvellous power which is so entirely under the command of the engineer, that he can alternately strike a blow of

10 or 15 tons, or crack the shell of a filbert without damaging the kernel, readily suggested a mode for raising a piece of ordnance which might be of the heaviest description, and yet must be elevated with precision and certainty. These were reasons why I first held a preference for this mode of accomplishing the object I had in view. The steam power, now always available on board our ships of war (and especially at a time when there would be, as in the case of an attack on a fortress, a quantity of this valuable element escaping to waste), was an inducement to work the guns of my new fashioned vessel by that power, but more mature consideration satisfied me that it would be imprudent to trust to this power alone, as in the event of its failure during an action, or its being all required for the purposes of locomotion, the armament of the ship would be placed *hors de combat*.

I have therefore abandoned, in some measure, this motive power, and though I am not without belief that by a judicious arrangement of counterpoises, the guns might be easily raised by manual labour, yet I would prefer considering this only as a substitute for the other method, which I must now describe.

When, in a ship drawing about 20 feet of water, the engineer desires to blow out his boilers, he finds that if the pressure of the steam is reduced to about 9 lbs. on the square inch, he must find some other way of emptying them; in other words, the pressure of the water on the bottom of the ship, is equal to about 9 lbs. on the square inch. Now, this is the power I employ for lifting my guns.

In the hold of the ship, I place five cylinders with pistons of a diameter and a length of stroke sufficient for the work required, and arranged with valves to admit water through the ship's bottom; always bearing in mind that as the upward stroke is made, the pressure decreasing, an excess of power is required in the first instance. Now, I derive from this arrangement several advantages over the use of steam; the motion is more steady, and each gun has its independent motor; moreover, the piece is supported upon five columns of water, and I conceive, is thus more easily sustained at its required altitude than if these were columns of steam. But I *do not* require a power equal to lifting the entire weight of the gun, for I have arranged counterpoises at the sides of the vessel, which by chains are so connected with the framework of the gun-platform that a great deal of the weight is transferred to them, and these counterpoises are by preference plates of iron, which form an extra protection to the crew, and are available for the detention of those death-dealing splinters and fragments of the modern-days shell, which all practical men declare, are more to be dreaded than the round shot, which blunders in at a port and carries itself with a whole skin through the other side of the vessel. This counterpoise of course rises and falls to correspond with the motion of the gun, and is kept in its position by several chains so as not to become useless should any one of them be shot away.

We must now suppose the gun to have been raised by the pressure of the water admitted into the cylinders to the level of the upper deck, guided securely and with precision by stout upright iron stanchions on

the fore and aft side of the platform, which has cheeks on its periphery to receive the same.

The deck is prepared for action by letting down the falling bulwarks into the recesses prepared for them in the iron-plated deck. The gun is run down the inclined plane by the crew below, the palls having been raised by a tripping line arranged for the purpose and acting with the running-out tackle. Should the object have altered its direction during the process of raising the gun, the gun can be re-directed by the crew from below, as the pinions and elevating screw have square heads on their under side which can be worked by keys. The piece is fired by the captain of the gun, who is thus enabled to look out when the object is on through his directing tube, should there be any rolling or other motion in the ship.

The gun upon firing recoils, and the shock of the discharge is greatly relieved by the powerful coach-spring which is affixed to the rear of the gun-carriage, and which abuts upon projections terminating the metal slides on the inclined plane. The valves are then turned to allow the water to escape into the hold of the ship, where it is used for the boiler-feed or injection, or into a convenient reservoir. The gun is thus gradually lowered into a place of security, and iron shutters which are constructed to slide under, and thus close up the circular aperture, are drawn into their places, and thereby the crew are protected from the effects of a shell bursting over the vessel.

I will now very briefly enumerate the advantages I propose for my new method of fighting guns.

1stly. I can convert any broadside vessel with comparative ease, and inexpensively, into a vessel to carry the heaviest ordnance on my plan—the ordinary hatchways in the deck of a ship being easily convertible into gun-apertures—and this will not interfere with their use as hatchways under ordinary circumstances, for they may still be fitted with skylights, as shown in the model, or hatches for battening down and with hatchway-ladders made to slant over the gun when it is secured below for sea service.

2ndly. I can carry the heaviest ordnance in greater numbers than a ship of the same tonnage encumbered with iron turrets, and I can place the weights as may be found most convenient, low or high, or in any middle position to suit the trim required.

3rdly. I can fight my guns with complete protection for the crew, as far as the impenetrability of an iron side can avail to exclude an enemy's shot or shell.

4thly. In case of a shot or shell penetrating the ship's side, the loose compensating plate will receive the splinters, and thus protect the men from the danger which has been remarked as so imminent whenever a shot pierces the sides of an iron-plated vessel.

5thly. The gun can be fought as an upper-deck gun entirely when exercising at a target, or at very long ranges, when the men are not exposed to an enemy's fire.

An objection might be raised as to the recoil of a very heavy gun, both regarding the concussion upon the platform and hence to the glands of the steam or water cylinders. But this model shows an

arrangement which obviates this danger. The five piston-rods are connected at their upper ends by means of a wrought iron plate, which is a counter part in form, but not in thickness, to the gun platform. Upon this the latter is entirely supported, without in any way being connected therewith, and I may add that the whole concussion of the discharge is received upon the beam-ends of the vessel.

The heavier the ordnance, it would appear the less the recoil, for, I find, upon reference to the official reports of the trial of the Horsfall gun, that with a charge of 50 lbs. of powder, and 250 lbs. projectile, at point blank range, the recoil was only 4 feet 9 inches.

In a heavy sea-way I employ an extra stanchion on the other quadrants of the platform not provided with the iron guides or upright beams before alluded to, but as these would only be required when the ship was rolling or heeling over, or in bad weather, they may be usually kept suspended to the beams overhead, as shown in the model.

It must not be lost sight of, that the gunners in both land batteries and ships, working guns on my system, are not liable to be inconvenienced by smoke; and the "din of battle" would be to them less distracting.

I have prepared a model of an iron mantelet, which may be employed to protect the gun carriage, and a gunner, should it be deemed more certain, in obtaining an aim, to take the final sight for firing from the piece itself, which can also be discharged by the same man.

I must now direct your attention to this model of a land battery. The arrangements for working the gun are identical with those I have explained in the ship model, but as the ramparts of a fortress are considerably thicker than any ship's-side, the method of laying the gun does not apply. It therefore becomes necessary, after the gun is loaded, to send up a gunner with the piece to take aim, and he takes his seat on a wooden saddle beside the gun, and from this posture he is able to look along the sights, and, assisted by the gunners below, to lay the gun at the proper angle.

I propose that in a case such as this, an iron mantelet (similar to that I have shown in the ship model) should form a portion of the traversing platform, and this will be shot-proof to shell splinters or musketry.

I must trespass a few moments longer on your attention whilst I explain the method of raising the gun in land batteries, for though I have provided this model with five cylinders similar to the lifting apparatus for the ship, I am of opinion that water counterpoises would be the more preferable method, as weight would be no object in a fortress, the balance might be so nicely equipoised, that very little manual power would be requisite to raise the gun to its required level, and I prefer tanks filled with water to be employed as the counterpoise, because, in case the enemy should succeed in effecting the capture of a gun, by turning the water out of the tanks, they would be at once placed *hors de combat*. Moreover, whenever a command of water could be obtained, the gun might be entirely lifted and

lowered by alternately supplying the tank with more water, or drawing it off.

I must ask you to remark also, that guns mounted on batteries or ramparts on my plan, have the peculiar advantage of being as easily fired upon the flank or rear, as upon the face of the work. I hold this to be no small advantage, and I am in hopes that when my plans have been subjected to the opinions of engineers, they may obtain consideration from this peculiar advantage.

When the guns are not required for service, they are placed in their lowest position, and a skylight covers the aperture, which is fitted in the centre with a funnel; this, in winter, would be used for the exit of smoke from the gunner's quarters, and would supply air at other times.

The delicate structure of modern-days ordnance, seems to demand that extra care should be taken of the guns, and by my arrangement they would be constantly under cover.

I have now to thank you, Mr. Chairman, Ladies and Gentlemen, for your kind attention to my imperfect discourse. I owe my thanks also to the Council of this invaluable Institution for the courtesy with which (upon hearing of my invention) they afforded me this opportunity of making my plans public, and I trust they will accept from me the assurance that I feel much flattered at the honour they have conferred upon me; and last, though not least, to you Ladies, for your presence, and the interest you have manifested in my discourse. This, I presume, must arise from a belief that the comparative safety of those who do battle for you and your homes, is the object of my invention, and thus wisely you agree with the sentiments of our great English Poet, who declared that, "A victory is twice itself, when the achiever brings home full numbers."

Mr. OSBORNE called attention to a plan which has been patented by Captain Mathews, of the Leicestershire militia, also for raising and lowering guns on a moveable platform. Some conversation ensued as to the expediency of taking the plan into consideration on the present occasion, and eventually, it was arranged that the necessary papers should be submitted to the Council for their decision, as to whether they should be read in the Institution at a future day.

Rear Admiral Sir F. NICOLSON, Bart., C.B.: I do not wish to detain the meeting more than a few minutes. There are so many points connected with this invention, that I think it would be quite impossible for any officer, or even for any naval architect, and I see a very distinguished one present to give an opinion off-hand on the matter. I would suggest to Captain Inglefield that he should, when his paper is printed, give us all the details connected with it; all the measurements, of which I think we have had none this evening. We should like to know the size of all your cylinders. Could you tell us the draught of water of your ship?

Captain INGLEFIELD: This is a model of a ship of 1,800 tons burden, drawing 19 feet of water.

Sir F. NICOLSON: Where would the water line be?

Captain INGLEFIELD: This is a model to show the principle of the thing. I confess I have not calculated more than actually to obtain the area of the cylinder to lift a certain weight with a certain pressure of water. I find the pressure of water at a height of

20 feet	would be	8·7 lb.	at the bottom of the ship.	
17 feet	,,	7·66 lb.	,,	,,
15 feet	,,	6·65 lb.	,,	,,
13 feet	,,	5·64 lb.	,,	,,

Showing the variety of pressure at different heights. I should, of course, have entered more fully into the description, only I was limited to an hour, and I was anxious to make my paper short, in order to give gentlemen an opportunity to discuss the subject if they should be inclined to do so.

Sir F. NICOLSON: That is one point. There is another point I do not quite understand; you claim that those plates, which you call the counterpoises would protect your men. But when your gun is up, the plates are down on the next deck?

Captain INGLEFIELD: They are, of course. They do not protect the men at all times; but while the gun is being loaded and the men are in motion about the gun, the counterpoises are in some measure a protection not only to them, but to the man who is pointing through the aperture. It is merely an extra protection, used as a counterpoise to the gun, and made available to catch splinters.

Sir F. NICOLSON: But when that counterpoise is down in the lower position, it does not catch splinters.

Captain INGLEFIELD: Of course, it does not then, except in case a shot should come through the lower part; but the counterpoise need not remain so low, it may be carried up on the deck.

Sir F. NICOLSON: Then, with regard to the gun itself, I presume while it is on the deck it is completely exposed?

Captain INGLEFIELD: Not completely exposed when the mantelet is on, such as I have shown here.

Sir F. NICOLSON: It will not be exposed you mean to say, because your mantelet protects it. But if I understand the arrangement, your mantelet only protects it on one side. Then with regard to the pointing, I should like to know how far as to training either fore or aft, you can point the pointing tube; because as far as I understand the thing, your pointing tube labours under the disadvantage of a broadside gun, while your gun on the upper deck by which it is pointed has a range all round?

Captain INGLEFIELD: Yes, it is so far true that the gun has a range all round; but we must always bear in mind that there are the masts and the rigging, and that though the gun bears all round, it could not be fired all round. Nor could any deck gun on a turret ship. The mantelet protects the gun in the direction of the line of fire. It may be made larger than what I have shown here.

Sir F. NICOLSON: Suppose an enemy on each side?

Captain INGLEFIELD: Then it is liable to be exposed on the unprotected side. But my claim is that the gun is only exposed for a very small portion of time; that time being while it is run out and fired; for the instant it is run in, it is lowered.

Captain JASPER SELWYN, R.N.: As an old messmate, I get up to compliment Captain Inglefield on the ingenuity and talent he has displayed in doing that which is a very novel thing, making the column of water which is necessarily displaced by the ship a source of motive power. However we may disagree from him with respect to the peculiar conditions under which he employs it; still it is a very valuable feature, and it is a novel one, which promises very considerable results. Whether the counterpoise will go on acting with exact equality under the circumstances of heeling, of course is a point open to doubt; but I have no doubt Captain Inglefield has provided sufficient surplus power for that purpose. But there is a point on which I have remarked before, with regard to the cupolas—(Captain Coles has not been here to give me an answer on that subject); and I should like to ask Captain Inglefield how the difficulty that I alluded to is got over. It is this: in all centrally placed guns, the instant the ship heels over, it is true on the broadside you may get a depression of six degrees; but on the bow and not very far on the bow, or towards the quarter, you must necessarily fire through the deck, if you want to bring your guns horizontal. It strikes me that that is a considerable objection to the employment of a very large proportion of pivot-guns as the armament of large ships. If, in the course of Captain Inglefield's answer, he will be kind enough to touch upon that point, and show how far his ship may heel over without interfering with the bow or the quarter, in pointing the gun to windward, it will be a very great difficulty set at rest. With respect to the angulated

sides, I think that feature has received its chief blow from the fact that the very heeling over brings the angulated side on the lee side, in as unfavourable position as it would be if the side were upright. At long ranges where the trajectory causes the shot to impinge on the plate at an angle, all the advantages to be obtained from the angulation are lost. Some gentlemen think the trajectory a piece of professional slang; but I think those who are accustomed to artillery will scarcely doubt that it has its effects, and that the deck is the most vulnerable point in all ships owing to that very fact. With regard to the employment of the pointing tube, I am happy to be able to relieve a brother officer of a difficulty, by drawing his attention to the fact that by means of a small prism of glass, you may deflect the ray of light coming from the object, so that a person on the main deck or the lower deck can see his object quite as well as if he were looking at it. So that the tube is not a necessity, it can be done away with. I am afraid we shall find the counterpoise liable to very considerable difficulty. It is a familiar fact to all engineers that whenever you have to deal with a moveable platform, the weights vary, the weight increasing with the upward movement and decreasing with the downward, that is to say, if having a pound weight on my hand I move it downwards with a velocity of one foot per second, I have positively subtracted from the pressure of that weight; if, on the other hand, I move my hand upwards with a velocity of one foot per second, I add to the weight. That is a consideration which is of considerable importance in all these cases, and which would lead to complications, that I am afraid would throw the counterpoise out of work. There is also, as in all these cases of supporting heavy weights on stanchions rising from the bottom, very considerable variation in the pressure due to the moveable platform from the heeling and tossing about of the ship at sea. These are considerations which would require very accurate and close calculations before we could admit that they were perfectly met. That has shown itself a good deal in the cupola ship that has been sent out, the "Royal Sovereign." They have shown that, owing to a want of consideration to that fact on the part of some gentlemen connected with it,—I beg distinctly to say that I am not referring to Captain Coles,—the bottom has bulged, and the whole of the bearings have altered.

Sir F. NICOLSON: I met Captain Osborn to-day, and asked him about it; and I assure you it is quite a mistake.

Captain SELWYN: I take the published accounts.

Sir F. NICOLSON: I pit Captain Osborn against the published accounts, and I leave it to the meeting to say which authority they will take.

Captain SELWYN: I had not heard it; and I am glad to hear it on the authority of Captain Osborn. Still I think the objection will apply, because if there is any alteration in the ship in harbour, there will be much more alteration after she has been at sea. With regard to the system as applied to fortifications, I think Captain Inglefield, when he spoke of tanks in the battery, must have contemplated getting the water from tanks at a distance. Because it would be imprudent to rely for raising your guns upon tanks in the battery which might be pierced. And as to the power of firing to the rear of forts, if that applies to sea-faced forts, I think by the time you have to fire at an enemy in the rear, you would have to get out of the fort altogether. For other forts, particularly in the nature of a martello tower, it would be a most valuable peculiarity to be able to fire landward or seaward. The application of the principle to large ships I have ventured to call in question. But I must now say that by no means do my remarks apply to small gun-vessels, which have no such protection as they require, and which must evidently have some protection when we go to war, with the iron-cased ships now forming the bulk of fleets. For I must deny that the "Enterprise" is a well-protected ship. Captain Inglefield has said it is known that no four-and-a-half inch plate is a good protection to a gun. Therefore it is folly to rely upon no better protection than this for our small gun-vessels. Moreover, a ship whose velocity may be ten knots an hour on trial, I beg leave to doubt whether she will get more than nine knots, when she gets all her stores on board. If that be so, and this vessel be a corvette, of what use would she be? The light vessels, which should be the eyes of a fleet, if we are ever to have a fleet again, should have the greatest speed. Vessels such as the Confederates have, skimmers of

the sea, may come down on your convoy and snap them up and be off again before your corvette can get near. Therefore I do not think the "Enterprise" is to be named as so satisfactory a class of vessel as some of the papers give us reason to believe. I shall be glad to see (and I have no doubt, as time progresses, that Mr. Reed will be able to give us) something much better than the "Enterprise." No one will be unwilling to recognise the readiness which he has shown to adopt improvements as they arise, and to give us some of his own. Therefore I hope some of the improvements he will in future adopt, may give us an efficient light tonnage vessel, well armed.

Commander SCOTT, R.N.: I will merely make one or two remarks. It appears to me that the introduction of that sort of machinery on board ship is out of place, for I think the heaviest gun can be worked very readily without. My own view is, that rather too much stress is laid on the disadvantage of ports, from not considering how armour-clad vessels are to be fought. Seeing that you will have very few guns in future, and very heavy guns, I think you should discharge those guns, and then sheer your vessel off slowly, and that will close the ports. If you have to raise the gun and lower it, you lose a great deal of time, just at the very moment when you want your gun to be fired as rapidly as possible in close action. At a distance, the raising and lowering of your gun certainly cannot be of much value, nor would you attempt to do it. With regard to supporting the gun, as Captain Inglefield proposes by columns of water, I very much fear whether the holes in the ship's bottom would not tend to weaken her considerably. I agree with what Sir Frederick Nicolson has said about the gun being exposed, that it is a very serious objection in a large gun. I think the closing of the apertures over the gun by shutters is not likely to be attended with good effects, because if a heavy shell fell on deck, a one-inch shutter would not keep it out, and if you had a two-inch shutter, you would have such a mass to move, that you would not be able to work it at all. In truth, the more simple you have all the things connected with naval warfare, the better. The observation Captain Inglefield made just now, about the delicate guns we are likely to have, rather confirms this. We have those delicate guns, but they have been already shown to be a mistake. Those guns are fast disappearing. No breech-loader is being made at the present time; the whole of the breech-loaders will be removed, and we shall soon have no heavy breech-loading guns at all. So that we shall have guns as simple as possible, that will stand work, and will not require any arrangement of the kind proposed to protect them.

Commander DAWSON, R.N.: I should like to ask a question with regard to the want of uniformity of pressure on the ship's bottom. I suppose there will be two or three guns mounted towards the extremities. There must be some parts of the ship being raised out of the water while others are being dipped into the water, and there will necessarily be a difference of pressure. How is that to be got over in the working of the gun? Again, I do not quite apprehend this point, when a gun is fired with great elevation, there will be a great pressure downward, which may come upon one side of the platform; and thus, it appears to me it would act upon one or two of the cylinders only. I did not catch the explanation of how that was to be got over. Another point I did not quite understand is, how the connection between the telescope and the traversing of the gun is to be kept up in the rolling and pitching motion of a ship, so as to follow the object quickly, and to communicate the wishes of the captain of the gun as to its movements, without the interposition of several second captains to read off and regulate the several elevating and training arcs. Those are the only points that occur to me at present; and I believe I am doing a service in asking these questions.

The CHAIRMAN: I have some observations to make. In a vessel of that size, with a gun of a calibre for a 400- or a 500-pounder shot, what time would you allow for raising the gun and lowering it, and for the process of loading again, lifting it up and firing it? I must express my gratification at hearing this application of a power which has never been made use of before; and which, if not exactly carried out upon the principle you have laid down, will, I think, be a useful hint that may be improved upon and applied by and by. I quite agree with Captain Scott, that when you have a heavy gun upon the deck, if you are fighting

at a distance, you will not want to lower it. Your gun will be sufficiently protected by the distance, and you will take your chance; by not being lowered down every time, you can fire a greater number of shots. Therefore, taking one objection with the other, I think the advantage of being able to fire much faster, though the gun may not be so well protected, is a greater advantage than that of lowering the gun down to load after every discharge. This remark applies to firing at a considerable distance. When you are near your enemy, then rapidity of fire is a matter of the utmost importance. I remember, in the action off Trafalgar, the ship I was on board, engaged a Frenchman. She ran aboard us with her sprit-sail yard into our main rigging. We had six guns on each deck to bear upon her; and it was the rapidity of the fire which changed entirely the fortune of the day. In the course of thirty-six minutes she had 434 of her crew killed and wounded, and all her masts were by the board. She came alongside us with her royals set, and in thirty-six minutes that was her state. It was the rapidity of fire that did the mischief. Fortunately ours was one of the few ships in those days in which gunnery had been very much attended to; and our men were able by their superior rapidity of fire to beat down the fire of the Frenchman. The result was, that throughout the whole action we had only about 90 men killed and wounded, while the Frenchman lost 434 men, and was disabled in thirty-six minutes. That shows how important it is to be able to have rapid fire in close action. Then, again, it is a most important object to make use of heavy guns in the simplest manner possible. I am glad to see men of your talent and genius occupying yourselves in so important a subject as that of working very heavy guns, because we certainly must come to the use of heavy guns. With guns of calibre for shot of 400 lbs. or 600 lbs. no thickness of armour-plating could ever be made that would resist such shot. I mean for sea-going vessels. Therefore it is a matter of great importance that we should be able to make use of the heaviest guns, by land and by sea, in the simplest and easiest manner. About two years ago, in a pamphlet I published, I proposed to make the ship the gun carriage, and to take up the recoil by a succession of buffer springs, and always to fire these heavy guns on a line with the keel. I believe, according to the size of the ship, you might have two, three, or four of these guns at each end, with screws at each end, and guns at each end. Of course, a new system of tactics would be required with ships of that kind. When they fight, they must always keep the bow towards the enemy, and combine the action of the ram with the guns. As this is the first time I have heard the details of the plan which you have given us, I confess that I have not quite followed them. But as a sailor, I think you will agree with me, that for the firing of your guns you cannot have the arrangement too simple. When you are very close, you must have very rapid firing; and when you are at a distance, protection is not of much importance. I must make an observation with regard to Mr. Reed. Mr. Reed has had a hard task to work. In the handiness of his vessels, he has certainly made great advances upon the former most unhandy vessels, which (as far as my experience goes) are deficient in all the material qualities which are essentially necessary to constitute an efficient man-of-war for coast service as well as for ocean service. We shall require coast service more frequently than ocean service; therefore vessels of extreme handiness and rapidity are very necessary.

Captain INGLEFIELD: I came here quite prepared for a discussion of my plans, so novel as they are. I did not expect to find all my brother officers agree with me; and I am glad to find that they have no more serious objections to urge than those which have been brought forward this evening.* In reply to those questions, I will answer the Chairman first. First, with reference to what has fallen from you and myself upon the subject of Mr. Reed's vessel, I would like to explain the expression I made use of in my lecture, when I said that until the time Mr. Reed became Chief Constructor of the Navy, we had all but one opinion; naval architects and naval men believed it was only possible to have very heavy guns and very heavy armour on large ships.

Sir F. NICOLSON: With great speed.

Captain INGLEFIELD: With great speed. That, I think, was thoroughly understood. Now Mr. Reed has produced vessels that, so far as the experiments are re-

ported, have been highly successful. So I read in the official report in the public prints, and that much I quoted in my paper. Captain Selwyn has referred to the counterpoises that I employ for assisting to raise the guns. He thinks they would not rise and fall with sufficient accuracy, and that there would be a difficulty in guiding them. It is possible there might be. But I do not find there is any difficulty, however much a ship may heel, in the rising and falling of the pistons of the cylinders in the larger ships, or of the slide valves, or in the rising and falling of the sliding gear in a vessel, that rises and falls many times in a minute. Therefore I think with a suitable arrangement there would be no difficulty in working these counterpoises, which have nothing but their own gravity to keep them in their places. They might be carried in the lower part of the ship, in convenient slides and uprights for making them work exactly. Objection was made to the holes in the bottom of the ship, by which the water is to be supplied to the cylinders. But it must be borne in mind that all ships of modern times have some eight or nine holes in their bottoms, and yet we never hear of much going wrong. They are fitted with valves. These holes are employed for blowing out and supplying the boiler. And with such openings as these I would feed my cylinders by which the water is supplied to the pistons. Therefore I do not consider that any great difficulty would be occasioned on that ground. The shutters which I use for covering the aperture are not intended, like the deck which is covered with a certain thickness of iron plate, exactly to keep out a falling shell; but it is intended to protect the crew from the splinters of a shell which may burst over the aperture. Of course, if they were made of the weight and thickness of the deck, there would be great difficulty in moving them.—With reference to the pressure of water when a ship heels over in a seaway, I may reply, that if one portion of the ship is heeling over, and is thus much out of the water, the other portion of the ship is so much the more immersed. Therefore the pressure upon the cylinders would be equalised in that manner; upon one side the pressure might be greater, while upon the other it might be less. Conveyed through a table or a platform such as I have in this model, quite independent of the gun-platform, and worked in suitable slides, I consider that the gun itself would always rise at a perfect level, and that the platform would carry it perfectly truly. One gentleman spoke of the difficulty of aiming the gun, while the captain who is looking through the telescope is not actually at the breech of the gun. But I should explain, what must be familiar to most of you, that the captain of the gun does nothing himself with regard to the laying of the gun, except to look along it. He orders the handspike-men, and the men at the side tackles, "Muzzle to the right! Muzzle to the left! Elevate! Depress!" And so the captain of the gun, in this instance, will look along the tube, and will read from the arc the angle at which it should lie; and, instead of saying, "Muzzle to the right," he will say, "Two degrees before the beam!" or, "Two degrees abaft the beam!" At long ranges, I think you said, Sir George, that it would not be necessary to lower the gun. You remember, perhaps, that in my paper I said specially that when firing at a target and at long ranges, the gun might be fought entirely from the upper deck; and I believe, moreover, my gun would be applicable to fighting from the upper deck with less exposure to the crew. For I showed you by this arrangement the gun is run out entirely by the crew below; and if this mantelet is employed, the gunner may sit in a protected position looking along the gun, and giving his orders through the open aperture to the men below, who will train the gun by means of the pinions and ratchet work in the direction required. The gun upon its running in, if it is a breech-loader, may be loaded on the upper deck easily; or if the men are fighting upon the upper deck, they may load it, two men being exposed only for a moment, and retiring upon the gun being fired. Therefore I think the gun may be fired even as an upper deck gun. With regard to the advantages of a central gun or pivot gun over a broadside gun, I conceive that one point has not been alluded to, which should not be lost sight of. It is this: we are coming to a period when nothing but the heaviest ordnance can avail for our war ships. We find that ships, however thickly they may be coated with iron, and however well-protected with teak backing or iron lining, can nevertheless be penetrated. Therefore we must employ heavy guns for such work; and if heavy guns are to be employed, I do not think that they can be carried upon a broadside; that, in fact,

they must be in some position where a ship can carry in a seaway, or in a gale of wind, such an immense amount of metal as is contained in this very heavy ordnance. I therefore believe that such heavy guns must be carried as central guns. I propound this plan for carrying very heavy guns in a central position, as having the advantage of carrying half the number that I should require in a broadside ship. For clearly my guns can be fought on either side, instead of carrying a double number, which you must always do in a broadside ship.

Captain SELWYN: Will Captain Inglefield be kind enough to remember the question I asked about the bow to windward when the ship is heeling over?

Captain INGLEFIELD: I do not think that that is a question that any one is in a position to answer; for let the ship heel, place your gun as you may, you cannot fire from the centre of your ship across your bows without firing through your deck, unless you have a turret placed so high, that you can point clear of that immense range of deck.

OLIVER LANG, Esq.: I have one remark to make, viz., the lecturer has stated that all naval architects thought it impossible small sea-going ships could be built to carry armour plates, and that until Mr. Reed showed us how to do so we had no idea of anything of the kind. For myself and every naval architect I am acquainted with, I entirely repudiate that statement. The lecturer tells us the "Enterprise" is a vessel that "has done wonders, that she has attained a speed of near ten knots." Now the speed of the "Warrior" is about fourteen knots, and what chance would a vessel like the "Enterprise" have at sea with the "Warrior;" but if the "Enterprise" is designed only as a coasting ship, then a vessel could be built of the same size as her that would do everything she can do, and draw from two to three feet less water. That naval architects supposed the "Defence" the smallest size ship that could be built to carry armour plates, I entirely repudiate.

Captain INGLEFIELD: In reply, I can only say that the reports I have read of the experiments with the "Enterprise" and "Research," are such, as have led me into this error, if error it be, that they have achieved very large advantages, which had not been anticipated by naval architects and by seamen. I have had no opportunity of going out in the vessel. I have read the report from which the words, pretty nearly, that I have used myself have been quoted, that until Mr. Reed laid down these vessels, the "Research" and "Enterprise," it had always been considered that great speed, heavy armaments, and sides iron-protected far below the water-line, could only be carried in large vessels.

Mr. LANG: Then ten knots you consider to be high speed? I do not; and although I do not believe the "Enterprise" will realize more than nine knots, I give her ten; but what chance would such a ship have with one like the "Warrior," having a speed of fourteen and a-half to fifteen knots. Why *she would be out of sight in less than two hours.* It is well known that a ship that has to carry heavy weights must, if required, to attain high speed, have less displacement given by size and not by filling the fore and after ends, as with a bad formed ship it is impossible to obtain high speed, and that if ships are equally well designed, and have power in proportion, the speed of the large ship will always exceed that of the smaller one; but when the large one has a speed of fourteen and a half and fifteen knots, and the small one only ten, what chance can the latter have; it is absurd to compare the one with the other.

Sir F. NICOLSON: You used the word "official report," just now. Is it the report in the *Times* that you have read, or have you seen any other report?

Captain INGLEFIELD: I confess I have seen no other report; but this was often spoken of as an official report.

Sir F. NICOLSON: I want to explain to the meeting the value of these reports. I have had some experience of the reports under the head of Naval and Military Intelligence, which appear in the newspapers. At Woolwich I have had two years and a half experience of the accuracy of these reports, and if the meeting will be good enough to take it upon my testimony, I can assure you that they are frequently very inaccurate.

Mr. LANG: An old master shipwright who had been at Chatham a considerable number of years, told me the most surprising thing was, that when he saw anything

in the papers of which he had the means of knowing the correctness or not, he always found the report incorrect.

Commander SCOTT: Will you allow me to say one word more, as Captain Inglefield has mentioned a point which ought not to be passed over without comment; that is, as to working heavy guns on a broadside.—No heavy guns were proposed to be worked upon the broadside at all, until it was proposed in this Institution about two years ago.—The proposal was first mentioned here in 1862. But the vessels that Captain Inglefield has been speaking of, were only built to take the guns then in the service, the 68-pounders and the 110-pounders, which are not the heaviest guns. I wish to mention that, because it was in this Institution that the plan of working heavy guns on the broadside was first brought forward. If Captain Inglefield will refer to the journal, to the report of Mr. Barrass's lecture (I do not know whether it has been published or not) he will there find not only that heavy guns were proposed to be worked on the broadside, but that the means by which they were to be worked was particularly described—guns up to 24 tons.

The CHAIRMAN: With regard to the *critique* upon vessels, that, I think, is not the immediate subject of your lecture; it is the working of the gun.

Captain INGLEFIELD: Certainly; but reference is made to what I have stated. One more remark with regard to the newspaper reports, that Sir Frederick Nicolson has endeavoured to explain. I may say, and I think it is known to you all, that it is a very common thing to bring before much larger and much more important assemblies than this, the reports of the newspapers. In the House of Commons we frequently find paragraphs read and discussed from the newspaper reports. Therefore, I am not very much out of the road in having taken for granted what appeared in the *Times*, which I may perhaps qualify by calling it a semi-official report respecting the trial trip of the "Enterprise." Upon the semi-official report I based my argument. If I am in error, those gentlemen who have been in office, and who know what were the actual performances of the vessel, are far better able to give an opinion upon the subject than I am. I yield to them in that respect; nevertheless, I cannot desert the gentleman whom I spoke of before (Mr. Reed); though I have never seen him but once in my life, and therefore, he is no acquaintance or friend of mine, I believe him to be a very talented gentleman, very well adapted to the position in which Government has placed him.

Mr. OLIVER LANG: When the statement was first mentioned by the lecturer, I thought it was so foreign to the subject of the lecture, that it would have been encroaching on the time of the company had I noticed it; but when the lecturer repeated that naval architects did not know that a smaller ship might be built to carry armour plating, I thought then, that I really could not leave the room without setting him right; as it would have been thought that I agreed with the lecturer in every word he said. The lecturer tells us that he has given us these statements on the reports of the *Times*, that the "Enterprise" is a most signal success. I ask him what he conceives to be a signal success? If by a stretch I make the speed of the "Enterprise" ten knots, and if by a stretch in the same proportion, I make the speed of the "Warrior" fifteen, then I ask him whether he thinks ten knots in proportion to fifteen, a great success?

Captain INGLEFIELD: In reply to that observation, I think I quite meet the views of the Council in saying that this is not the time nor the occasion for discussing the merits of the "Enterprise," or any other ship. I therefore feel that I am not called upon to respond exactly, or to defend this vessel or that. I merely alluded to it as having read what I understood was the feeling of naval architects, and of naval men with reference to armour-plated ships of various sizes.

Captain SELWYN: As the discussion has taken rather a conversational shape, and as some points have been raised to which, as Captain Scott remarked, a reply could not be made previously, I may briefly notice a question which is a very interesting one, that of broadside guns against pivot guns, as regards the possibility of carrying broadside guns. I am totally at a loss to understand why, if corvettes like the "Tartar" can be built to carry ten 68-pounders of three tons each on the broadside, the same vessel cannot carry two ten-ton guns. It is very true the weight is more locally placed; but I conceive any naval architect will tell us that that can be met

by increasing the strength at the point which is called upon to bear it. Therefore, I do not see any very material difficulty as regards the carrying of the very heaviest guns that artillerists choose to make on the broadside of a ship, properly calculating for them.

The CHAIRMAN: If no other gentleman wishes to make any remark, we will thank you, Captain Inglefield, for the paper you have read,—for the able manner in which you have treated subjects of so much importance to the sailor as well as to the soldier. I am glad to find men of your character giving attention to matters of so much importance; and I hope they will continue their investigations. We are in a transition state. Everything connected with naval construction and artillery is a question of life or death to us. I hope the attention of both services will be called to it, and that we shall frequently have papers read on the subject with the ability and ingenuity which you have shown.

Evening Meeting.

Monday, June 6th, 1864.

CAPTAIN E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between May 30th and June 6th, 1864.

Malcolm, William, Lieut. 2nd Batt. 10th Regt. 10*s*.
Inglefield, E. A., Capt. R.N., F.R.S.
Hopkinson, William, Capt. London Rifle Volunteer Brigade.
Moore, Francis, Ensign 8th The King's Regt. 10*s*.
Fonblanque, B. A., Ensign 8th The King's Regt. 10*s*.
Sewell, T. D., Capt. Lond. Rifle Volunteer Brigade.
Hight, Edmund, Lieut. Royal Naval Reserve.
Hinton, Fredk., Major 1st Dorset Art. Volunteers. 10*s*.

ON THE DRESS AND ACCOUTREMENTS OF THE INFANTRY OF THE LINE.

Contributed by Major LYNDEN BELL, Unattached, and read by the Secretary.

WITHIN the last few years, much has been done by His Royal Highness the Field-Marshal Commanding-in-Chief, and those in authority, to improve the condition of the British soldier. Libraries, reading-rooms, gratuitious instruction, better food, and more liberal allowances of clothing, have been granted and provided; his social position has been raised, and facilities have been given, and inducements held out, to acquire education and habits fitting him for the higher grades.

For these measures we cannot be sufficiently thankful. Advancement is taking place in other directions also. No effort is spared to promote general efficiency; the divisions of the army are massed, and permanent camps of instruction have been established, by which an effective organization is kept up. Troops are now habituated to act in large bodies, and valuable experience is thereby gained, both by staff and regimental officers.

The soldier, moreover, is now armed with an excellent rifle, and taught to use it. It would be impossible to particularize each step

which has been taken in advance, but when we look back upon what *was* the state of our army, after the long peace, and compare it with the army of to-day, the country has reason to rejoice.

There is still another source of congratulation, which must not pass unnoticed, namely, that the slur which it has been customary to cast upon our Staff, will soon be (if it is not already), a thing of the past, for the Staff College sends forth a class of officers, which, in education and practical qualification, equals, if not surpasses, the standard of the "Etat Major" of any army in the world.

I have dwelt on these matters because they are encouraging to all who have the welfare of the Service at heart, and desire to benefit it, in however slight a degree, and accordingly I submit this paper, on the vexed question of the dress and accoutrements of the Infantry of the line, for charitable consideration, and shall feel glad if any part or parts of it are thought worthy of notice.

There is an old saying that "Fine feathers make fine birds," and it is applicable to the soldier. If we make him proud of his uniform, he will hesitate to disgrace it.

Smart men are, as a rule, those most to be depended on in the hour of danger, whereas the slovenly fellow, who does not care for his appearance on parade or in the streets, almost always lacks *esprit-de-corps*, and fails to be of use when he is most needed. But, as limited expense is a consideration of the highest importance, let me premise that though I would have the soldier proud of his *soldier-like* uniform, I would not decorate him unnecessarily with one extra button, or one extra piece of lace.

Chaco (See Plate XXIX, Fig. 1).—A commencement must be made, so let us take the several parts of the dress, seriatim, beginning with the chaco.

Truth to say, many improvements have been from time to time introduced in its shape and size, so that the field for reform in this particular is proportionately lessened; one evil still remains, namely, the convex peak, which, merely from the weight of the chaco, as it stands on the barrack-room shelf, becomes injured, and put out of shape.

The straight peak has not this defect, and having been recognized as "regulation" in the forage caps of officers, I trust it may be soon substituted for that at present worn with the chaco of all ranks.

Forage Cap (Fig. 2).—In a temperate climate, the general efficiency of a soldier is not affected by the shape or cut of his forage cap, but as our troops serve in so many latitudes, it is wise to adopt something which is alike a partial protection from cold and heat, covering the head, and giving shade to the eyes, neither of which are effected by the regulation cap of the present date. Without desiring to go to our neighbours, the French, for every material military improvement (as has formerly been the case), we might borrow the cut of their cap with advantage. Its sides should be without stiffening, so that it could shut down flat, and the colour dark blue, regimental number worked in red.

With such a forage cap, and appropriate cover, we could (as the

S K E T C

Marching Order.
(without Gaiters)

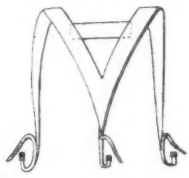
Marching Order.
(with Gaiters)

Marching

Fig. 4.

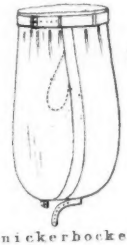
Make-believe Stock.

Fig. 5.



Ammunition Braces.

Fig. 6.

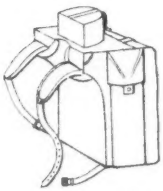


Knickerbocker

Fig. 7.

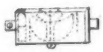
Hose.

Fig. 12.



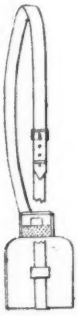
The Knapsack.

Fig. 13.



Cap Pouch
Large Size

Fig. 14.



Bidon

Fig. 1

T C H E S .

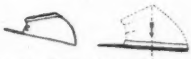
Marching Order.

Undress.

Fig. 1.

Chaco.

Fig. 2.



Forage Cap. Do. pressed down.

Fig. 3.

Tunic.

Fig. 7.

se.

Fig. 8.

Legging.

Fig. 9.

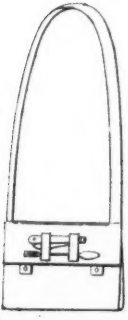
Boot.

Fig. 10.

Fig. 11.

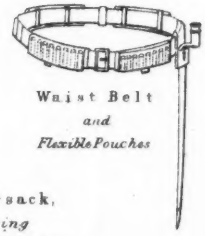
Fatigue Jacket.

Fig. 15.



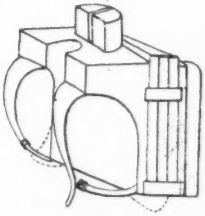
Haversack, *shewing Knife, Fork & Spoon inside*

Fig. 16.



Waist Belt *and Flexible Pouches*

Fig. 17.



J. R. Johbins

French have often done) go through a campaign in a hot climate and dispense with the chaco.

When we add a peak to our own cap, we render it ridiculous; the addition being so much out of character.

Tunic (Fig. 3).—We all cling to the memory of the good and lamented Prince Consort with kindly feelings of respect. It is to him that the army is indebted for the introduction of the tunic, and the consequent rejection of the coatee.

In the tunic, as first issued, several changes have been made, the cut, the length, and the material have been altered.

It will not then be novel if other modifications are approved of from time to time, nor, we feel assured, would the Royal Prince himself, were he alive, stand in the way of any palpable amendment.

Every day proves that the radical error in the uniforms of British soldiers taken generally, is tightness or closeness of fit, which, under the plea of giving smartness, not only robs them of ease and comfort, but impairs their general efficiency as destructive agents, and prevents them from having the unconstrained use of their limbs, either in fighting, marching, or works of fatigue.

It would be far better if a less constrained and easier style of dress found favour with those who are all-powerful in such matters, and I hope we may yet see the day when such will be the case.

The tunic which I submit for consideration, is full and loose in the body, but gathered into plaits or folds at the waist, giving freedom to the lungs, and having extra thickness round the stomach; colour scarlet, the cloth double at and over the shoulders, for the twofold purpose of keeping out rain and preventing the knapsack gear from giving uneasiness.

Colour of regimental facings as at present, bound with black cording.

There is one inside breast pocket, on the right side, but none in the skirts, which are short.

On the left breast there are two studs, firmly sewn to double cloth, for the purpose of holding the cap pocket.

The collar is very low, and as the regulation stock is highly objectionable, in that it is an impediment to the breathing, and *very* uncomfortable, I have dispensed with it, and have substituted a pliable leather lining to the collar, which shews slightly above for neatness and cleanliness' sake; the ends of this "make believe" project towards the front and cross (Fig. 4) at the throat, being fastened together by an ordinary stud, the holes for which can be cut so as to suit the thickness of the neck.

By the foregoing, we attain all that is necessary, viz., cleanliness and comfort. To continue, there are inserted under the lining of the proposed tunic, leather braces protected by padding (Fig. 5), they come out under and over the waist-belt, and sustain the ammunition, which I propose as subsequently explained to carry round the waist; at each point where the ends of the braces come out, the waist-belt is strengthened by a small piece of metal, which forms a bed for the strap, and is capable of adjustment, by sliding on the belt according as circumstances require.

Knickerbockers (Fig. 6).—We perceive that sportsmen, and men to whom money is no object when comfort is concerned, have gone back to the knickerbockers of the past ages, and found in them a garment preferable in every way to trousers, while undergoing violent exertion and fatigue.

Several of the smartest of our volunteer corps have adopted them, and find that they answer every expectation.

Let but one regiment of the line, try, and report upon them, and I feel sure they would not be condemned.

They look soldier-like, and, as with them shoulder braces are unnecessary, the restraint so imposed, and the discomfort of loss of buttons are done away with.

They can be easily sustained by a light leather strap, running through loops at the waist-band, capable of being tightened or the contrary.

The colour which contrasts most favourably with a scarlet tunic, is dark blue; but tartan, for Scotch regiments, would look very well; let there be a broad red stripe down each side, and the fastening at the knee a leather strap and buckle, and give them an ample pocket at each side.

Each man should have a pair of blue cloth for winter, and of blue serge or some other blue material for summer, and for change, flannel in the tropics would be suitable.

Hose (Fig. 7).—Dark grey or heather-coloured hose would accord well with dark blue.

There is one point which strikes me in mitigation of expense, viz., that as the foot of the hose or stocking is the part most exposed to wear-and-tear, the foot part and leg part should be complete in themselves, and joined together by sewing; this would give the means of adding a new foot to the leg of the hose if the former was worn out, and no ravelling of the worsted would take place.

In hot weather, and on the line of march, when not necessitated by wet, the hose should be worn unprotected; but for night-work, or otherwise, a light, waterproof, canvas legging, bound with self-coloured leather, and fastened by three buckles and straps, would keep out rain, wet, and cold (Fig. 8).

The Ammunition Boot (Fig. 9).—We have descended gradually from the chaco to the boot; but in considering these subjects, their importance increases rather than diminishes; for, whereas an ugly chaco (though unsightly) does not impair general efficiency, it is imperative that the soldier should have a good boot.

That submitted for adoption, is fastened by two strong buckles and straps, so as to give neatness, by admitting of extension or compression according to the size of ancle, and height of instep; the soles are made to project beyond the uppers, and the heels are low and broad.

The "*string system*" now in force in the boots of the infantry, is untidy, and uncomfortable, and does not afford support to the ancle.

A man with well-fitting boots feels more active, his step is more elastic, and he is capable of marching with less fatigue, than when he

is encumbered with such as are loose, misfitting, and wanting in identity with his foot.

Shirts (Fig. 10).—"Flannel next to the skin" is a preventive against pulmonary complaints, and many other "ills that flesh is heir to."

Whether the climate be warm or cold, it is equally useful; in the former, it prevents the checking of perspiration, and in the latter, it keeps the wearer warm. Men exposed to such vicissitudes, and to night air, as soldiers are, require every protection that can be afforded to them; and the average mortality being so much greater in the ranks of the army than in civil life, it would be true economy to try all feasible means to lessen it.

One step in the right direction would be gained, if flannel shirts were given to the duty soldier of the line; the necessity is recognised for the volunteer force, at pages 72 and 73 of the Regulations affecting them.

One soldier lost, is more to be deplored, taking the matter in a low, pecuniary sense, than the outlay of very many flannel shirts.

Our army is small, and the nation whose honour it is called on to support is great and rich. If there *be* extra expense, is not it well that it should be incurred in such a cause and with such an end?

Even two flannel shirts would be sufficient to meet the emergency; both could undergo inspection on the day that the clean one came from the wash; and on service the soldier could wash his own, thus having a change at all times in his possession; but give him three if necessary.

The flannel shirt of a soldier (particularly as I advocate it to be worn with knickerbockers) should be of more than ordinary length behind, and might then fasten by buttons or strings to the front, and prevent the chafing which is so liable to occur on the line of march.

Fatigue Jacket (Fig. 11).—The design of fatigue jacket submitted is looser and longer than at present; the collar is leather, lined in the manner described in the remarks on the tunic, facings the same, colour scarlet, fewer buttons, loose sleeves, and plenty of room in the shoulders.

When we see the caricatures of our men by the French, under title of "Types Militaires," we must be struck with the absurdity of the *shell* jacket, and the idea thus presented is confirmed by practical experience, namely, that as a garment, it requires the *smallest possible piece of cloth in its office of encasing the body.*

Accoutrements and Appointments.—Let us as a commencement do away at once and for ever with *pipe-clay*, removing that stigma *practically* from the soldiers' belts, pouches, straps, slings, &c., as it is being gradually removed, in a theoretical sense, from all other matters connected with well-being and discipline.

Those in favour of pipe-clayed belts, on the ground that they look well on parade, should turn to the reverse of the picture, and see them on active service in the field, exposed to rain and mud; they should remember the experience of the Crimean campaign, and the appearance they presented then in the smartest of our regiments. Nothing indeed could be more different, and nothing could be more dirty than they

were. The men can hardly be blamed by the strictest disciplinarian for this natural result; they were constantly employed at one duty or other, they had not time even to rest. The "*Buff*" requires too much of this time to get it up to the parade mark. In winter, the weather was too inclement to dry the belts (if any attempt was made to pipe-clay them), and it was indeed lamentable to see the once clean soldier of England with nothing of his pipe-clay left; his filthy belts showing how unserviceable they really were, and how unlike what they ought to be.

Leather belts, straps, and slings, of their natural colour, on the contrary, do not suffer a similar fate on service, they *are* what they seem to be, there is no such fall from great show to abject dirt. They are always ready, they do not require so much care, time, and trouble, and consequently *afford* more time for that *great essential—rest*, and for the important duties of the camp. Little beginnings very often lead to great results, and even the dirty once pipe-clayed buff belt may discourage the clean soldier of former days, give excuse to the slovenly fellow to be more dirty still, and thus affect the "morale" of all.

To proceed, I have, as a general rule, introduced plain buckles and straps whenever a fastening of the kind is required in the knapsack, belts, or accoutrements, such being to my view the simplest and readiest method of attaining the end sought.

The Knapsack (Fig. 12).—The part of the soldier's equipment which it is most difficult to provide in a perfect form, is the knapsack.

In considering it, several points seem to present themselves as essential:—

First. That the weight should be so disposed, as to be sustained by those parts of the human frame most capable of bearing it.

Second. That it should be easy to the wearer, and possess identity with his movements, without cramping the action of his limbs, or pressing upon the lungs, or any other vital part in an injurious manner.

Third. That it should be sufficiently large to carry all required for a short campaign, without being objectionably heavy.

Fourth. That it should be capable of being taken off and put on again by the wearer without difficulty or loss of time, so that advantage may be taken of any temporary halt to enjoy the rest and relaxation of being without it.

Fifth. That the cost of making it should be limited to a small sum.

How many of these conditions are filled by the Regulation knapsack?

Partially it fulfils point No. 3, but its fittings are incomplete and complicated; it does indeed cost but little, and so provides for point 5; in other respects it is wanting; for although its weight is raised to the shoulders by means of the "stick," and it now no longer falls into the hollow of the back (as a very smart officer of my acquaintance used to say), like a "tinker's wallet," yet the pressure of the stick on the vertebræ of the back near the neck, is very unpleasant indeed.

Military men know by experience, that rarely is the soldier found who can take off and put on a full pack unassisted. It requires the

kind offices of a comrade, who in his turn needs the same; consequently men prefer keeping the burden on to taking it off, when the halt is only temporary, the trouble outweighing the advantage in their eyes. Such being the case, it is too clear that there is much room for improvement.

In the pack now presented for consideration, I have begun by taking it as a rule, that if we conform to the natural curve of the back, neck, and shoulders for those parts which come in contact with them, we secure more of ease and "identity" than is the case when we strap a plane surface to a curve.

Thus the inner side of the knapsack (that is the one next to the body) is curved as it approaches the shoulders, and projects in fact over them, the shoulders and collar bones being protected by padding on the inside of said projections. Having thus secured a base on which to build, viz., the shoulders (which are most capable of sustaining weight), we can raise the knapsack two or more inches.

Supposing us to be looking at the side of the knapsack, the curved line of projection above mentioned takes a course inwards, following the ordinary upward slope of the shoulders, and a passage for the neck is hollowed out, after the fashion of the yoke by which milkmen support their cans (see Fig.).

Having so far brought the pack partially over each shoulder, without hindering the free action of the neck, the next step is to secure it to the body, and keep it in the desirable position attained. To this end, broad padded springs, in continuation of the curve, and holding the pack to the body as required (without being too strong to press injuriously), are affixed to the shoulder projections at an angle which inclines inwards and upwards, conforming to the slope of the shoulders.

The pack prior to issue, can be fitted to each soldier, and the springs then screwed on to suit the breadth of shoulders.

At this stage we have the knapsack secured to the body, and kept in the position desired, with the weight disposed on the strongest parts of the frame, but in order to prevent its coming off when moving rapidly, performing the bayonet exercise, or when fighting, straps are provided; the right strap when once adjusted need not be altered, except when the knapsack is worn over the great coat.

At the termination of each spring pad, there is a ring, and to these rings that part of the straps terminating in the "tongue" are attached, the corresponding portions having the buckle being in the same manner permanently fastened to the lower corners of the pack. On the right side, the position of the buckle is under the arm, near the lower corner of the knapsack, and does not interfere with the butt of the rifle in firing. On all occasions the man is intended to slip his right arm through the loop when putting on his pack, just as one would put on a coat.

On the left side the portion of the strap having the buckle is longer, and the fastening is in such a position (viz., about midway) as to enable the right hand to adjust it easily.

It will be observed, that these straps from the relative position of the rings attached to the lower part of the spring pads, and the

bottom of the pack, which are their respective terminations, cannot cut the soldier under the arms, and are indeed more for the purpose of restoring the balance, if lost, than resisting pressure.

On the sides of the knapsacks are elongated pockets, one to hold three pieces of wood, which fit together like a fishing rod, for the formation of the pole of a *tente d'abri*, and are not much thicker than a walking stick; total length of four such pieces being about $3\frac{1}{2}$ feet: on the other side three light tent pegs and a piece of thin rope, about two yards long, to act as a stay for one of the tent poles. At the back of the pack, in addition to the great coat, are two pieces of light waterproof canvas, fitted with eyelet-holes and strong cord, and capable of being tied together (with an overlap to prevent rain entering), and form one side of the tent, or of separately acting as a cover for the ends of it, according to circumstances. In this manner any three soldiers could form an effective shelter from rain or dew.

It is barely necessary to point to the advantage of having a *piece* of *waterproof always in possession* on a campaign. Even when encamped in the regular ordnance tent, the waterproof sheet could be used, if needed, to lie on, and prevent or mitigate the evils arising from the exhalations of damp ground.

In many cases when *tentes d'abri* would be used, a considerable number of men would of necessity be on duty, and more room would thus be afforded to those left to occupy them.

It may be remarked that I have left the blanket out of consideration in the foregoing observations, but as we cannot overburden the soldier, a choice must be made between the blanket and a section of the *tente d'abri*. Let us consider their respective advantages.

After a night of rain, the soldier with a *tente d'abri* would commence his march in dry clothes, whereas with the blanket only, he would be saturated with wet; any advantage arising from the warmth of it would be rendered null and void by the damp. He must begin his active duties carrying a wet blanket (which is no slight weight),* and days and nights may pass without its becoming dry again. A wet blanket is of no service, but rather the reverse.

I have too much faith in the improved organization of our army, in respect to the military train, to doubt that there are very few circumstances which could arise to prevent the blankets of the men being *carried for them*. They could be served out after the march, and handed in at reveillé.

The time and trouble of pitching and striking ordnance tents might embarrass a flying column, but transport waggons sufficient to carry a blanket for each man ought never to do so.

Cap Pocket.—Fig. 13 represents the cap-pocket or pouch proposed; it holds the turn-screw, oil bottle and oil rag, in the inner compartment, because the ammunition pouches advocated are intended for cartridges only.

Water Bottle and Drinking Cup.—A civilian would be astonished to hear that there is actually no drinking cup provided for the men,

* When wet the increase of weight is about 75 per cent.

either in quarters or in the field, but such nevertheless is the case. On home service there is no means by which infantry can carry a supply of water to refresh them on the line of march, or during a field day.

When an army prepares to take the field, water kegs are served out, but no drinking cups.

The "water keg" is clumsy and heavy, it is only necessary to look at it and be convinced of the fact; whereas the "bidon" (Fig. 14), is complete in all that is required.

If the men had the means of carrying a supply of water on all occasions, when in "marching order," much "falling out" and straggling would be prevented.

The Haversack (Fig. 15).—To be of real benefit the haversack ought to be *waterproof*, it would then keep provisions, and (on a pinch) reserve ammunition dry; *now*, being only a common canvas bag, it, of course, cannot do so, and the contents, of whatever nature, suffer from exposure to rain.

The haversack, of which I submit a sketch, is waterproof; it is much shorter; there is a moveable calico lining, for the sake of cleanliness; it is intended to carry the knife, fork, and spoon, and extra ammunition, if required.

Ammunition Belts and Pouches (Fig. 16).—When a regiment moves in "double time," almost every man who can escape detection puts his hand to his pouch, to prevent the incessant and painful bumping which the acceleration of pace causes.

The weight of the cartridges, confined to a small space, falling and rising again at each step, has most injurious effects, either interfering materially with freedom of movement, by taking (as I have observed) a hand to keep the pouch steady, or (if the hand be not used) causing actual pain to the poor soldier, and making him glad indeed to drop into a walk.

From the above, we argue that the weight of the ammunition is not now disposed in such a manner as to favour rapidity of movement, the necessity for which is becoming more and more apparent.

Happily *gymnastics* have at last been introduced, and it is intended to cultivate in future the muscular powers of our men which have hitherto been neglected, and to promote emulation in feats of activity and strength, it being well known, that quickness of manœuvre and concentration on decisive points, are winning tactics, and that the relative power of armies, equal in efficiency in other respects, are in the ratio of their strength, multiplied by their rates of marching. Therefore if we can move more rapidly we increase our power, in order to do so, however, we must first take away the drawback alluded to.

To further this object, I submit the following, viz.:—

A plain strong leather waistbelt, passed through the three loops formed by the braces (see remarks under the head of "Tunic"), supported by them, and strengthened at three points.

This waistbelt is fastened by a buckle and tongue, and can be tightened or loosened at pleasure. Upon it are four close-fitting, long, pliable, 15-round pouches, which are each secured by two close spring

hooks, but which may be taken off and slipped on again, or can slide round on the belt if required.

Each pouch is made sufficiently deep to hold a cartridge. Standing on the bullet end there is a separate case for each cartridge; they are arranged "two deep," eight in the front or outer row, and seven in that next the body.

Each pair of cells (front and rear rank) are soldered together, and attached to the side of the pouch, next to the body, but not to the outer one, or to the cells on each flank, thus *giving pliability*.

From the shape and position of the pouch, each pair of cartridges radiate towards a common centre, and leave room for an extra cartridge case in the outer line, which is fastened to it independently.

The pouch is waterproof.—When the ammunition in the front pouches is expended, they can be slipped up and put on behind, the full ones supplying their places.

Approximate Dimensions of each Pouch.—Taking the bullet at a diameter of 55 inches, the exterior length of each pouch would be about $5\frac{1}{2}$ inches; interior length, $4\frac{1}{4}$ inches; depth, $2\frac{1}{4}$ inches; breadth, $1\frac{1}{2}$ inches.

To sum up, we have, by the foregoing plan, disposed the ammunition round the waist in close pliable pouches, which take the circular form necessary. We can, by tightening the belt, prevent any jerking movement whatever, and we have the weight supported by shoulder braces, so that it cannot act injuriously upon the loins. We can remove the pouches in a moment if desirable, and they are impervious to rain; the cartridges are carefully preserved from the injury of knocking about in the pouch; and finally, the disposition of the weight is such that a man can move rapidly without suffering the pain and inconvenience, to which under the existing state of things, he is subjected.

For home service on ordinary occasions it is not absolutely necessary that any ammunition should be carried, as, when required, it could be served out in a few minutes. Nevertheless, I contend that it *may* be carried in the separate cells of the pliable waterproof pouch with less injury to itself than under the present system.

To make my remarks on the foregoing subjects complete, a calculation of the weight and expense of the accoutrements and appointments should be added, but any such calculation must necessarily be but a rough approximation, and a poor guide to the actual cost, because, when made in large quantities, articles of any kind are produced at a much cheaper rate than in isolated cases; but if item be taken after item and compared with those at present used, it will be found that the additional expense is inconsiderable, more particularly if the increased efficiency and comfort of the soldier be thrown into the scale.

On the score of weight, the service marching order I have advocated, is, I have no doubt, lighter than at present, and I must leave it to the judgment of my readers whether the weight is or is not better disposed.

The time *will* come when the "military necessity" of having a knapsack of some kind will present itself to our gallant reserve, the Rifle

Volunteers, and as by them improvements in arms, equipments, &c., &c., can be freely tested, I am sure that benefit to the regular service will, as a consequence, result.

I wish I could persuade them to give a trial to my knapsack and method of carrying the ammunition, and if not found to answer expectation, shall be rejoiced if they can improve upon them.

In conclusion, I tender my thanks to any one who may read this paper and forgive the homely style of its composition, in the consideration that it is offered for the soldiers' good.

Post Scriptum.—As it may be thought that the knapsack already presented for consideration is undesirable on the score of expense and liability to breakage, I submit the plan of another (Fig. 17) on the same general principles, but which has no boards (my former one has a skeleton frame), springs, nor padding, and is therefore lighter, cheaper, &c. It comes more over the shoulders, so as actually to rest upon them; it is fastened to the body by straps, but from the disposition of weight they do not cut under the arms, nor hinder free action. At the back of the pack there is a stick at the top, and another at the bottom, which run horizontally from corner to corner to keep the outside in shape, and yet admit of the inside surface conforming to the curve of the back when under pressure. These sticks are made of hard wood, and fit into small leather sockets. The knapsack being pliable, it is opened from behind. I confess that the more I think over this subject the more I am led to the opinion that framework or boards are *not* necessary in a service knapsack. If it be full, its shape will be sufficiently apparent to prevent its being very unsightly. If it be empty when it ought to be full, the delinquent cannot escape detection, and when we come to actual contact with the enemy, any saving of weight, provided efficiency is not sacrificed, is a decided benefit.

Concluding Remarks.—The accompanying paper has only for its object to bring under consideration a better mode of dressing and accoutring our infantry.

In advancing views on this subject, the present dress, accoutrements &c., &c., have been unavoidably (and perhaps freely) discussed, but the writer earnestly trusts that nothing which has been brought forward will be deemed a manifestation of the slightest disrespect for existing regulations.

The CHAIRMAN: We shall be very glad if any gentlemen have any remarks to make upon this paper. The subject is a very interesting one.

Major-General BOILEAU, R.E., F.R.S.: There is one point I would wish to make an observation upon. The writer of the paper mentions that to support knickerbockers braces are not necessary. He seems to forget that all men's figures are not alike, and I can give him this assurance, from an experience of fifty years, that if I were to attempt to wear knickerbockers without braces, I should very soon be in a position that I should not like to be seen in. In some cases braces are as necessary for knickerbockers as for trousers.

Major-General Boileau, R.E., F.R.S.: In reading this paper, I beg to observe that I am only acting as the mouth-piece of Lieutenant Walker, Assistant Instructor of Musketry at Fleetwood, who cannot be present, and I have, therefore, to premise that I am not answerable for any of the opinions expressed.

BREECH-LOADERS FOR THE ARMY, AND GUN-COTTON AS AN EXPLOSIVE AGENT IN MODERN WARFARE.

By Arthur Walker, Esq., Lieut. 79th Highlanders, Lieut. Instructor School of Musketry, Fleetwood.

The announcement recently made in the House of Commons by the Marquis of Hartington, that two thousand breech-loaders were to be placed in the hands of the troops, to be tried and reported on, will, we believe, be received with unmixed satisfaction by the public in general, and the army in particular. The conviction is fast gaining ground amongst all classes, that the breech-loading system, in some shape or other, must, before very long, be adopted for the army of England.

It will be observed, however, that the step in the right direction taken by the Government is merely one of a tentative character; and therefore, whilst it is still under consideration, and pending the inevitable "report" sooner or later to be sent in, it may not be inopportune to seize the present moment for ventilating some of the important points which the recent course of events has developed or brought to light with respect to breech-loaders as a *military* arm.

It is almost superfluous to remark, that with the exception of Prussia and a few special corps in other countries, breech-loaders have not been introduced into the armies of Europe; and therefore, if we would learn something as to how breech-loaders work practically as military weapons, we must go to Prussia for our information.

The "*Zundnadelgewhr*" or needle rifle, called so from the ignition of the charge being produced by a needle being passed through the cartridge to strike the percussion powder, was introduced into the Prussian service in the year 1848, and the following may be regarded as a correct and comprehensive description of this fire-arm.

* "The barrel, AA, (Fig. 1, Plate XXX), which is 34 inches long, is rifled with four grooves (Fig. 3), and has a "hausse," or sight, adapted to distances of 600 metres. It is screwed into the end of a strong open guider or channel BB. The chamber, properly so called, is bored out

* Vide Sir Howard Douglas's work on Naval Gunnery, 5th edition, p. 560, et seq., whence Figs. 1, 2 are taken.—A. W.

Fig. 1.

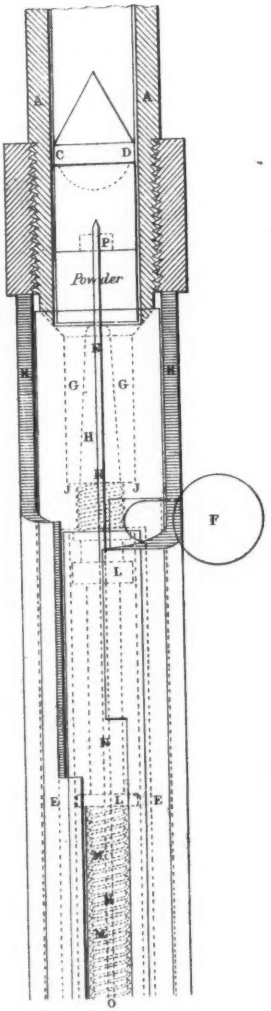


Fig. 2.

Fig. 3.

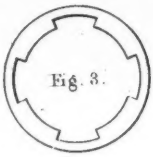


Fig. 4.

Fig. 5.

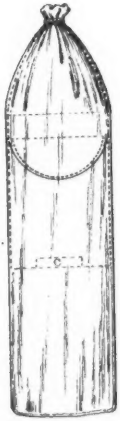


Fig. 6.

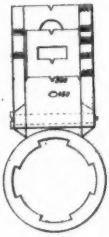
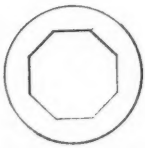


Fig. 7.



from behind, conically in a slight degree, so that, when the cartridge is placed in it, the shoulder, CD (Fig. 1), of the ball shall meet and be stopped by the projections or ribs of the rifling, the body of the shot being of sufficient diameter to fill the full depths of the grooves. Inside of the guider slides an iron tube, EE, with a strong "hebel" or handle, F, and having at the front end a space, GG, of about 1½ inch in length. In the middle of this space is a "tige" or pillar, H, which, instead of being solid like that of a pillar-breech musket, is pierced with a small hole in its entire length, and through this passes the needle N, which is to ignite the charge: the steel tige is screwed into a solid plate of iron, JJ, left in the tube EE, and this plate it is, which (like the breech-pin of the ordinary musket) receives the whole reactionary force of the charge."

"Behind the plate, JJ, there is a second tube of iron (which could not be shown in the drawing) having a double catch spring attached, and carrying within it a small inner tube of iron, KK (Fig. 2), having two projecting rings, LL, on one moiety of its length, and a spiral spring, MM, (Fig. 1,) sliding on the other half. Through the tube, KK, passes the needle, NNNN, which is a thin steel wire about ·03 inch diameter, bluntly pointed at the end, which is to ignite the charge; at the other end it is screwed into a brass head, O, and this again screws into the inner tube, which carries the spiral spring. The trigger, which is of a peculiar form, and has a bolt movement in firing, could not be shown intelligibly in the diagram."

"At the lower part of the barrel is the sliding tube through which passes the needle for igniting the charge. This tube is capable of being moved backwards or forwards in the barrel near the breech by means of a pin, or handle, in its side, which passes through a perforation similar to a bayonet notch in the side of the barrel. When the tube is drawn as far as the perforation will allow towards the stock, there is formed an open chamber between its extremity and the nearest extremity of the barrels and by means of this chamber the charge is introduced into the barrel. The tube is then pressed forward till its extremity, which is in the form of a frustum of a cone, is in contact with the rear extremity of the barrel; this extremity having the form of a hollow cone to receive the end of the tube; the pin or handle being then turned round in the notch, the tube is, as it were, locked in close contact with the barrel. In this state the needle in the tube is in connection with the trigger of the lock, and the musket is ready for being fired."

The grooves shown in Fig. 3 have a uniform depth and twist, with one turn in 42 inches. The bullet is ogival in form (Fig. 4), and weighs 451 grains, and is fired with a charge of 65 grains of powder in the cartridge. The powder is separated from the bullet by a rolled and compressed paper cylinder, which is hollowed at the end next to the bullet, so as to fit the base of the bullet (Fig. 5). It has also a cavity at C, in which is lodged the fulminating composition to be exploded by the needle driven into it—thus avoiding the use of caps, priming, &c. The elevating sight (Fig. 6) is in part fixed and in part moveable; it is lowered in its position on the barrel either to the front

or to the rear. The cost of the gun is not great, being only between 12 and 13 thalers, or from 36 to 39 shillings English.

The salient properties of the needle-gun may be taken to be the following:—It can be loaded and fired six or seven times in a minute, more or less, according to the skill and dexterity of the soldier. Of course this does not suppose and include time for a careful aim; but when firing into masses, at short distances, very little aiming is required, owing to the flatness of the trajectory on such occasions. All that the Prussian has to do, is to open the lower end of his rifle-barrel—which is done by a most simple contrivance—to take a cartridge from his pouch, which he wears in front instead of behind, insert it without biting or breaking, shut to, and fire. There is no ramming down, which exposes the man when in front of the enemy; no fumbling with tiny caps, hard to feel with cold fingers, but everything is simplified and well-adapted to the desired object.

It has been objected by military men that this kind of gun would easily get out of order; but according to the correspondents of the newspapers, the Prussian officers, who in time of peace always stood up for the excellence of their weapon, are more than ever satisfied with it now that it has been tried in war. The soldiers do not treat it as if it were a very delicate weapon, but, on the contrary, knock it about in loading and handling, quite as much as it would be proper to do with any other kind of rifle.

By a singular coincidence, the field in which this breech-loading rifle was first practically tested was the same as that in which it has recently asserted its terrible destructiveness; and although in the former abortive war between Prussia and Denmark this was not perhaps developed to the same extent, yet the bloody battles of Kolding, Fredericia, and Ilstedt attest only too fully the deadly effect of its fire. At the latter engagement, it is related, that in seeking to dislodge some Prussian infantry from a bridge, the Danish infantry and cavalry were, in a very short time, nearly decimated; the General in command was struck down, the chief of his staff wounded, and nearly every other officer either killed or wounded in less than an hour.

Since the period in question, no effort has been spared to improve and develop the advantages of the needle-gun, and during the Crimean war one million thalers, or £200,000 were voted by the Prussian Chambers, in excess of the preceding year's expenditure, with the view of extending its manufacture and securing its issue to every soldier in the Prussian army.

The wisdom of this forethought on the part of the Prussian Government, and how this formidable armament has succeeded, may be gleaned from the various accounts which have reached us of the Sleswig-Holstein War, the din of which is still fresh in our ears. From the very first, whenever the Prussian and Danish infantry came into collision, and especially when these encounters took place between masses in the open field, during this deplorable war, the disparity in the losses has told fearfully against the Danes—to an extent, indeed, that at first appears wholly unaccountable. Observation and inquiry, however, soon demonstrated that this disparity was entirely attri-

butable to the superiority of the Prussian rifles. Firing rapidly, about three times as fast as the Danes, who were armed with the ordinary four-grooved, muzzle-loading *Minié*, they availed themselves of the intervals between the successive salvos of the enemy, to pour shot upon shot into him whilst loading. To this the Prussians were indebted for their success at Büffel Köppel, which secured the evacuation of that village and the outlying ground—the Danes retiring rapidly, leaving many men in the hands of the enemy, and carrying off a number of wounded.

A similar result ensued at the final capture of the Düppel forts; and the following episode has been quoted in proof of the effective fire of the needle-gun on the latter occasion:—A company of the Prussian Guards, following up the Danes after their retreat from one of the forts, drove a battalion out of a farm-house and the buildings which it occupied. On perceiving, however, the numerical inferiority of the force that had ejected them, and not seeing it supported, the Danes returned to the charge, and thought of retaking what they had lost, but the Guards opened upon them so formidable and continuous a fire with their needle-rifles, that they were glad and compelled again to beat a retreat.

Now one authenticated fact, such as this, is worth a host of conjectural speculations as to what breech-loaders might effect, and tends strongly to confirm the opinion, that steady soldiers, armed with breech-loaders, are a match for two or three times their own numbers. Had the Danes been provided with this weapon, how different might have been the result of the struggle, wherein this small but gallant nation has had to contend behind entrenchments against overwhelming numbers. Indeed, to nations with small, or comparatively small armies—like England—the breech-loader is imperatively necessary, since, by the very proposition of her paucity of numbers, each man should be equal to ten of the enemy on almost all occasions of conflict. Indeed the argument cuts economically as well, since if the present strength of our army be sufficient, when armed with breech-loaders it might be reduced in accordance with the increased efficiency secured by the weapon.

For our part, now that a breech-loader has been adopted as the universal arm of one great continental army, and as it is known that both the French and Belgian Governments are on the eve of taking a similar step,* we believe that no alternative is left us but to adopt the system without delay. It has just demonstrated its superiority. What more can we need? Can any "Report" whatever rebut the facts of the late campaign in the gory fields of unfortunate Denmark—unfurnished with a weapon which might have given her invaders a lesson to be remembered—instead of seeing her brave little army crushed before overwhelming numbers. Can we for an instant contemplate the possibility of our not taking the most speedy and ample measures to secure to England perfect immunity from such ruin and calamity?

* Since this article has been written the author has been given to understand that a breech-loader, on the needle principle, but much simplified, is being introduced almost universally into the ranks of the Federal army of North America.—A. W.

To hesitate in this matter is to be lost.

But even apart from these considerations, so vital to the existence of the nation, the adoption of the breech-loader is necessary on account of our almost constant state of warfare in some part or other of the globe. As Lord Elcho pertinently put it to the House of Commons on a recent occasion, what would be the position of an English contingent, if it should find itself opposed to a force armed with breech-loaders?* The alternative of making rapid charges, so as to resort to the bayonet, would doubtless be the practical solution necessitated; but, unfortunately, it is precisely in meeting or repelling such charges that the superiority of breech-loaders would become most evident; for, men so armed, and with bayonets fixed, can keep up a continuous fire *till the very last instant*—since, in a measure, it is never necessary to move the rifle from the position in which it must be held, when resisting the advance, either of infantry or cavalry. General Rêmond, of the French army, avers that infantry armed with breech-loaders, and readily "forming fours," will dispense with the usual formation of squares—which checks the advance of troops, and renders them so vulnerable to artillery. With breech-loaders, effectual fire of the deadliest kind could be delivered with a rapidity that nothing could withstand, namely, in four ranks, and even in five,—the first lying, the

second sitting, the third kneeling, the fourth and fifth standing. See accompanying diagram.†

In the presence of these facts, we may hesitate as to which *principle* of *breech-loader* we should adopt, but not for an instant as to the adoption of *the weapon*.

Undoubtedly the most cogent argument against the introduction of breech-loaders into the army, is the alleged likelihood of soldiers squandering away their ammunition; but this argument is very much like that which was advanced as fatal to the introduction even of the *Enfield*. Military men said it was too delicate a weapon to be placed

* In the debate referred to, Lord Elcho pointed out that although a Committee, appointed by the House itself more than two years back, had reported that a much better weapon than the Enfield could be manufactured at exactly the same cost, yet the manufacture of the inferior weapon had been continued at the rate of 1,000 per week, and the House declined, by a considerable majority, to endorse the conclusion of its own Committee or make any change.—A. W.

† This diagram is taken from "The Rifle, its Theory and its Practice," by the author.—A. W.

in the hands of the British soldier! Experience has utterly refuted the imputation. Of course, it must be admitted that a badly disciplined regiment, with careless officers and negligent sergeants, at the beginning of an action or campaign, would probably fire away its ammunition too quickly, but it may still be, that its effect, even in such hurried circumstances, would surpass that of ordinary rifles. Moreover, we have no right to assume that men trained to use the breech-loader, and constantly cautioned not to throw away their shots, would necessarily and perversely do so—with every consideration, both national and personal, to make them anxious to husband every shot at their disposal.

But what does the able correspondent of the "Times," who accompanied the Prussian army throughout the recent campaign, declare on this very head? He says, "I repeatedly asked the Prussian officers whether they found that the facility of loading had the bad effect of making the men fire too rapidly, and waste their cartridges; but they tell me it has not." And are we to be told that British soldiers will necessarily be less provident of their ammunition than the Prussian?

But surely, even supposing this objection were well grounded, and even insuperable, it would be better—rather than lose the manifold advantages resulting from the use of breech-loaders—to devise a method of impeding the soldier's access to his ammunition by some mechanical arrangement of the cartridge box. We cannot think such a precaution necessary for the taught soldiers of the British army; and most assuredly the appliance would be absurd, as actually defeating the very object we have in view—the utmost rapidity of fire combined with effect; and in venturing the suggestion our only object is to plead, by all means, for the adoption of this greatest military boon ever vouchsafed to the soldier. If the obstructive prejudice against breech-loaders in this respect prevents its adoption, we can take means exactly to regulate the number of shots he can fire per minute.

It was said, after the introduction of iron-plated ships, that any Minister who should send our sailors forth to battle in wooden ships, to their inevitable destruction, ought to be impeached; but what should be said of him who would allow our soldiers in any future war to be shot down whilst standing up to load his gun, during the tedious rodding and capping motions, when he might be armed with a weapon which would effectually prevent his exposing his body, and unnecessarily sacrificing his life?

At the great Hornsey-wood pigeon match the other day (2nd June), it was remarked that two-thirds of the guns used were breech-loaders, and that more than half the prizes were carried off by them, so that it would appear that the prejudices that existed when they were first introduced have gradually died away. Yet it appears a curious perversity of judgment that a breech-loader should be preferred for pigeon-shooting, deer-stalking, and cover-shooting, on account of its greater convenience and destructiveness, and yet refuse to the soldier the same advantages for dealing with his larger and more dangerous game.

There is another disadvantage connected with a muzzle-loader, which is not likely to present itself except to a man actually in the

service,—we refer to the time and labour required to be expended on the recruit to make him thoroughly conversant with and habituated to that dreadful platoon-exercise, which is one of our military perfections so completely in accordance with the slow-coach of battle in the 17th century. It requires a long time to acquire the habit of loading properly, so that in the hurry and excitement of the battle-field, it shall be as a second nature. Facts amply support this averment. It is related that, after the battle of Gettysburg, the muskets found on the ground not discharged were loaded, or rather mis-loaded, in the most extraordinary variety of ways. In some were bullets without powder, and in others powder without bullets. Others had cartridge after cartridge on the top of one another, whilst at the base of the nipple-hole a piece of paper appeared to have been carefully jammed so as effectually to prevent the ignition of the charge. Some, again, were loaded and capped ready for discharge, with the ram-rod left in the barrel.

But, indeed, we need not cross the Atlantic for illustrations of this malpractice; for, unfortunately, at the last Volunteer Review at Guildford, the death of a clergyman by a ram-rod driven through him, sufficiently testifies to the difficulty of getting indifferently drilled men to go through all their loading-motions correctly.

The action of skirmishers in future battles will be most important; and their special action consists in their well-aimed shots. But all know the difficulties of skirmishers in properly loading on the present system.

It is impossible to get all the powder down to its proper place; after a single discharge some of it must stick to the sides of the bore, even if the barrel be kept perfectly perpendicular—which is impossible in skirmishing. Besides, some must load kneeling or lying. Now it is certain that every grain of powder in the charge is absolutely necessary—the weight being the minimum.

There is absolute immunity from all these disadvantages in the breech-loader, wherein (with the Westley Richards for example) the loading simply consists in raising a lever, pushing in a cartridge tip foremost, and shutting down the lever. The rawest recruit could be taught his "platoon exercise" in the course of a single day, and the veriest tyro could hardly make a mistake.

We might dilate at greater length on the other numerous advantages, in the tactical point of view, which the adoption of breech-loaders would secure to the soldier; but most of these are really too self-evident to need any advocacy, and we shall therefore proceed to consider, in detail, the weapon experimentally issued by the Right Honourable the Secretary of State for War, to whom it is difficult to give too much credit for even giving the principle a trial.

The two thousand breech-loaders referred to at the beginning of this article, are made by Mr. Westley Richards of Birmingham, and the principle of construction is the one identified with his name, and as the weapon is likely in some shape or other to become a service arm, we proceed to give it a brief description.

Fig. 8 (Plate XXXI) represents a section of the breech-loading parts.

A is a gun-metal plunger which enters the breech end of the gun; B is a solid iron block with an inclined plane at the back, C. There is a second inclined plane at the point E, which throws the block B back into its place, and makes it fit close against the end of the box, F, which is also undercut, to fit the inclined part of the block, B, at the point C. The block has a sliding motion to allow this action to take place. By this it will be seen that the greater the pressure on the block and plunger the safer the part becomes, the inclined plane holding the lever firmly down in its place. D represents the cartridge. Fig. 9 exhibits the rifle ready to receive the charge, and shows how the breech is raised to load the gun, the junction being behind the cartridge. When the rifle is closed, a small lump, marked A in Fig. 10, is the only projecting part; in al. other respects the gun has the appearance of the ordinary rifle. The barrel is that of the Whitworth in every respect, save the number of sides in the bore, which are eight instead of six—hence the bore is octagonal (Fig. 7, Plate XXX). With the rifle proposed by Mr. Richards as a service arm, the bullet to be used will weigh 500 grains, certainly not more, and probably less,—the charge of powder to be 80 grains or 2·92 drs. The weight of the gun with bayonet is about 10 lbs., the barrel 3 feet in length, and much stouter than that of any musket made for our service. With this gun the following results were obtained at a target on a favourable day:—

20	shots at	600	yards,	elevation	1° 21′,	gave a figure of merit of	6·96 ins.
20	„	800	„		1°50″	„ „	11·85 „
20	„	1000	„		2°50″	„ „	17·50 „

Average shooting, taking all kinds of weather,

600 yards	9·50 to 10 inches.
800 yards	13·50 to 14 „
1000 yards	22·00 to 24 „

These figures speak volumes in favour of its precision of fire and lowness of trajectory; and for safety and simplicity of loading, we believe this weapon to be at present unsurpassed as a breech-loader; but, unfortunately, it is deficient in one essential speciality of a breech-loader,—it retains the detached cap system of the ordinary rifle, introduced at the beginning of the present century as a mode of ignition; consequently, its rapidity and facility of loading are sadly impaired and diminished.

We have reason to believe that Mr. Westley Richards himself suggested to the authorities the propriety of combining with his breech-loader some well-considered method for igniting the charge without the intervention of the now antiquated percussion-cap, by means of a direct detonation applied to the base of the cartridge, somewhat on the principle of the Prussian needle-gun; but he was at once told that the idea could not be for a moment entertained, because any such method was incompatible with the requirements of a military fire-arm! So, to fall in with some fixed and determined rule, the miserable little cap

is to be still supplied to the benumbed, agitated, or fumbling fingers of the fighting soldier on the field of death. The reply bears a striking and rather unlucky resemblance to that accorded to poor Captain Norton in 1824, when he first brought forward a self-expanding, elongated projectile, on the very system now universally adopted, viz., that a "spherical ball was the only shape of projectile adapted for military purposes."

Now, let us examine the question, and see what is really sacrificed by retaining the copper-cap system. It involves the necessity of carrying two distinct kinds of ammunition, and therefore increases the risk of its getting out of order two-fold; in other words, although a soldier's cartridges may be in a perfect state of preservation, should anything happen to impair his caps—which, by the way, must be carried in a separate pouch—it would at once render the soldier's rifle ineffective. Some of the caps may be dropped in capping or otherwise, and he may have cartridges without the means of firing. Everyone knows that there is oftentimes much annoyance and confusion arising from want of caps in time of action, and that either from carelessness or accident they run short long before cartridges.

Moreover, irrespective of the cap itself, the Musketry Book of Instruction, p. 18, assigns no less than seven other causes for the non-ignition and non-explosion of the ordinary charge in use, any one of which may occasion a miss-fire. Unquestionably the present mode of charging is utterly incompatible with the requirements of modern tactics, suggested and necessitated by the introduction of the improved rifle.

The practical result of this old system was well exemplified very recently, at the battle of Oversee in Denmark, on which occasion the Austrian rifles, owing to their having undergone some exposure to the weather, would not go off, and a part of the troops engaged had, in consequence, to charge with their bayonets over a long distance under a heavy fire from the Danes, with severe loss in killed and wounded.

In striking contrast with this state of things is the account given of their needle-gun to one present with the Prussians:—"The more they use it the more pleased they seem to be with it. This very morning I have been speaking about it with the adjutant of a fusilier regiment quartered here. He assures me it proves most solid and serviceable, never gets out of order or misses fire, not even when, as in the early part of the campaign, the men were lying out in the snow, and their arms got wet and covered with rust."

Now, unfortunately, owing to the peculiarity of the Westley Richards' cartridge, and the fact that it requires a very strong flame to penetrate the paper powder-case and the fatty lubricant surrounding it, a special description of percussion cap is necessitated; and hence, for a time at least, we must have to endure the evil of two kinds of percussion caps in the service. But even with this special cap, and under circumstances the most favourable, it is notorious that with the Westley Richards' breech-loading carbine, which has been served out to the cavalry for some time past, miss-fires are of very frequent occurrence, averaging

something like 20 per cent.* From whatever cause this serious result may proceed, the fact remains, and it can on no account be overlooked; but in drawing attention to it, we are anxious to point out that it is in no way attributable to the breech-loading system, as a system, which cannot be made responsible for the defect mentioned. The persistence in the use of the old cap is the cause; and had the authorities ever experienced the horrible revulsion of the feelings produced by a miss-fire in a moment of peril, they would doubtless recognise one of the "first requirements of a military arm" to be, the certainty of its fire on all occasions. Latterly attention has been drawn to the number of accidents, in the shape of flesh wounds in the face and injuries to the eyes, inflicted by splinters thrown off by inferior copper caps; the recurrence of such disagreeable contretemps tend materially to impair the soldier's confidence in his weapon, and the precision of his aim.

Perhaps, however, the most conspicuous objection to the employment of a separate percussion cap, is that it requires six separate actions of the hand to knock off the old cap, take up another, place it on the nipple, and press it properly home. An ungloved hand, in warm weather, can, of course, perform all these motions, with comparative ease and rapidity, on target-practice grounds; but having to do the same thing with a fur-glove, in a Canadian winter, during the excitement of active service, is a very different affair, and would constitute a disadvantage, even in breech-loaders, such as would seriously affect the issue of a battle, so far as that issue depended upon infantry.

At best, therefore, we can only regard this description of breech-loader as a sort of compromise or half-measure. Of course the consideration which really influenced the authorities in retaining the percussion-system, might be the safety of the soldier himself; but surely at the present day, with the Prussian needle-gun, and self-igniting cartridge, as a pattern to improve upon, and with our boasted mechanical skill and knowledge of chemistry, something could be substituted as a mode of ignition for that which is nearly as great an inconvenience and disadvantage as the use of the ramrod itself.

If any difficulty is experienced by the authorities in obtaining such a substitute, let the matter be thrown open to competition, and in this 19th century we feel well assured that entire success will be the result.†

* In justice, however, to Mr. Westley Richards, we should state that these miss-fires occurred with caps supplied by the Government Laboratory, and that with caps prepared especially by Mr. W. Richards, miss-fires were reduced to something like one per cent. Since the above was written, Mr. W. Richards has arranged to do away with all the lubrication on the powder part of his cartridges (which amongst other advantages makes them much cleaner to handle), and the Government are about to issue an improved service cap, which will make more than one description unnecessary.—A. W.

† Since the above was written, a Mr. Burton, from America, has exhibited at the Institution a breech-loading rifle, with metallic cartridges, carrying their own ignition, which appears to meet all the requirements of a breech-loading small arm as here indicated.—A. W.

Experience is said to teach; let it teach us before it is too late. We have seen how a brave people has had to succumb to enemies vastly their superiors, not merely in numbers, but in their armaments. Let us take the lesson to heart. Our army, numerically at least, is vastly inferior to those of the great continental powers; then let us make amends for any deficiency by the perfection and efficiency of our equipment and organisation in its minutest detail: and that which we have been considering is certainly one of the most vital importance to us, since it is equivalent to the question whether we shall triple, at least, our effective strength by the adoption of a good breech-loader.

As the Duke of Wellington often said, "Looking at the amount of mechanical skill in the country, and the numerical weakness of our army, as compared with those of the great Continental powers, British troops ought to be the best armed soldiers in Europe;" but until each soldier carries a well-devised and well-constructed breech-loader, with a rifled barrel, either on the *Lancaster* or the *Whitworth* principle, we must remain under the depressing reflection that our present armament is, in this respect at least, inferior to that of more than one Continental power.

The CHAIRMAN: Our gallant friend, General Boileau, need not to have repudiated any responsibility in respect to that paper. It is a very able one; we shall be very glad to hear any questions from gentlemen present, and I have no doubt the General will be able to answer them. Perhaps the gallant General will favour us with some observations of his own.

General BOILEAU: I should like to say a few words upon the subject of breech-loaders. The writer of this paper spoke of the form suitable for the grooving of breech-loaders as being either the Lancaster or the Whitworth principle. I think there is a great difference in the principle of those two forms of rifled bore. The Whitworth bore, being a polygonal bore, has angles which trench upon the metal of the barrel. I believe in a rifle which he has recently constructed, and which has performed such great feats at Woolwich, the barrel could not be made more than three feet long, to bring it within the limit of weight of 10 lbs., that being considered the maximum that a soldier ought to carry; and it certainly is the maximum. On this ground I think the Whitworth principle is not suited for a breech-loader, as an arm of precision especially. The Government at present appear to retain the idea, that for a military arm, the calibre should be comparatively large, and the late Duke of Wellington had the greatest objection to permit the bore of the old Brown Bess to be reduced at all; it was reduced, however, from something like 0·750 of an inch to its present calibre, which is 0·577 of an inch. An arm of precision requires that the bullet should have a certain ratio of length to the diameter, now generally assumed to be two and a half to one. In rifles of large calibre, the necessity of increasing the length of the bullet, even where the base cavity is very large, adds greatly to the weight. The bullet which Mr. Whitworth used at these wonderful experiments at Woolwich, where the figure of merit of his 0·577 bore rifle surpasses probably that of his small bore, had a weight of 600 grains. I have a rifle made for competition at Wimbledon with a very rapid pitch in the twist, retaining, as I was obliged to do, the Government bore; and I find that by the greatest possible care that can be taken to get a bullet which will give precision at long ranges, it is impossible to do so with the 0·577 bore, and to keep the weight of the bullet under 600 grains. Now, if the soldier has to carry sixty rounds of this or similar ammunition, you add 1 lb. to the weight of the bullets alone which he has to carry, and you add at least 1 lb. to the weight of the rifle. That is you cannot make a rifle with a 0·577 bore to carry a long bullet which shall not weigh 600 grains, and to shoot with precision up to 1,000 yards; and you cannot make a rifle sufficiently strong to resist the increased charge of powder, and the increased twist, under 10 lb. So that, I think, if a new form of

WESTLEY RICHARDS

BREECH LOADI

Fig. 8.

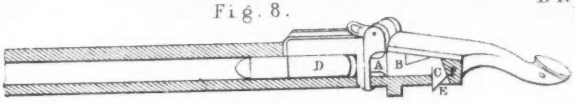


Fig. 9.

Ready to receive charge.

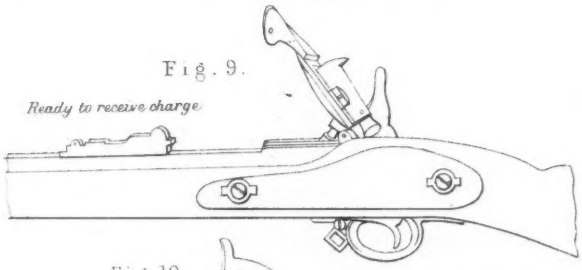
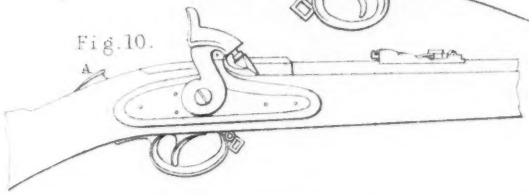


Fig. 10.



MONT STORM'S.

Fig. 21.

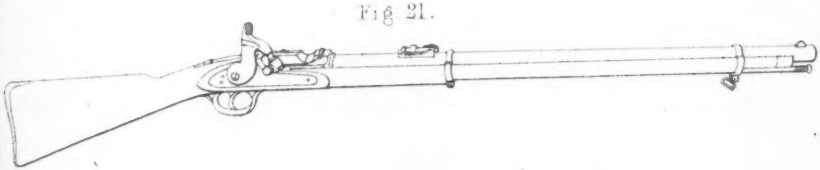


Fig. 22.

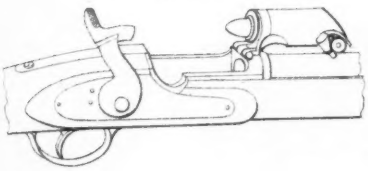
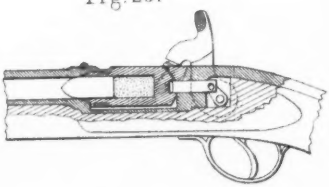


Fig. 23.



LOADING RIFLES

TERRY'S.

Fig. 11.

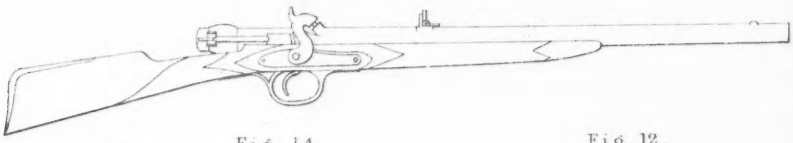


Fig. 14.

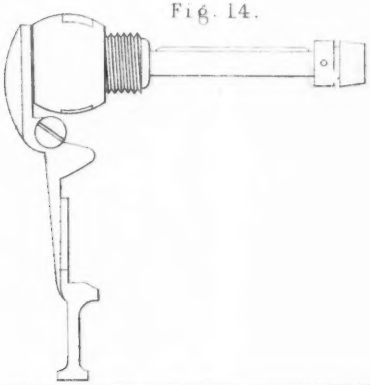


Fig. 12.

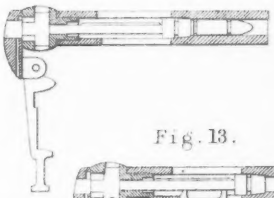
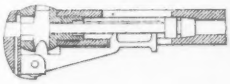


Fig. 13.



GREEN'S.

Fig. 15.

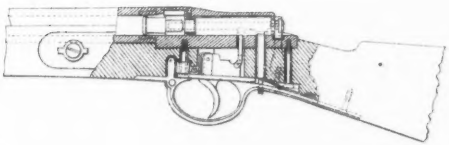


Fig. 16.

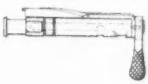
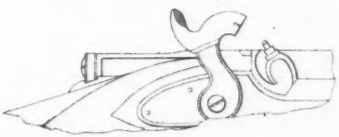


Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.



arm is designed, especially a breech-loader, it will be necessary to reduce the diameter of the bullet to such an amount as will admit of an elongated projectile which shall have the length to the diameter in the ratio of two and a half to one, or thereabouts, and which shall not weigh over 500 to 530 grains. This may be done with a barrel having a bore of half-an-inch. I have several rifles made of this calibre, which I hope to produce at Wimbledon. I find that a bullet with a diameter of ·488 inches, weighing 500 grains, gives a length of two and a-half times the diameter, and it secures precision of shooting up to 1,000 yards. A rifle carrying a bullet of that weight and of that diameter, may be made to weigh under 9 lbs. I have one which weighs about an ounce and a half under 9 lbs., and another which weighs rather less than 9½ lbs. By reducing the calibre, you secure lightness, and you secure length, with less weight of bullet; so that a man may carry 60 rounds in his pouch, and yet not be loaded to the same extent that he is now, for the Government bullet weighs 530 grains. Then there is another advantage in keeping to the smaller diameter. We shall not, however, come to such a small diameter as shall prevent the rolling of a comfortable and well-constructed cartridge. Now, the diameter of the small-bore Whitworth rifle is too small for this purpose. You cannot make a cartridge which will be sufficiently stiff to retain its form, and to admit of the bullet being loaded as at present. But with a half-inch rifle you can do so. I have made many cartridges, and have fired them out of my rifles with the same facility as I can with the Government rifles. That enables you to retain length of barrel. I do think there is no alteration in the form of a rifle which is more prejudicial in its usefulness in the hands of an infantry soldier, than taking anything, even half an inch, from length of the barrel. I believe in war we shall still have on occasions to decide the issues of a contest by close-quarter action, that is, with the bayonet; and there is no question that the man who gets the first prod, if it is only half-an-inch, has the advantage. Therefore, if you shorten your barrel by three inches, as in the Whitworth large-bore rifle, you put your soldier in a false position; his bayonet will be of no use against the longer bayonet and longer rifle of foreign nations. I hope to exhibit here a half-inch bore-rifle with a 3 feet 3 inch barrel and with a bayonet 3 inches longer than that now in use, and which shall not weigh more than the present Government rifle. Here are some rifles which I shall be happy to explain.* This is a Westley Richards' (Plate XXXI, Figs. 8, 9, 10); Lieutenant Walker thinks it the best design; I am not of that opinion, I think it has one disadvantage. It has a hinge and the breech-piece is fixed. In a breech-loading rifle, if it can be made for all its movements to be rectilinear, that is in a direction perpendicular to the faces which have to be brought together to close the breech, you are more likely to secure contact than you can by any application of curvilinear movements. A rifle has been invented by a non-professional gentleman, and to my apprehension it is the best that has been brought out. It is the design of Mr. Green (Figs. 15—20): its principal is that which I have always approved, that of rectilinear motion. You pull the breech-piece straight out, and push it straight in. The cartridge is dropped in as in Westley Richards'; the breech-piece is closed, the lever is turned down, and then the plug, by the action of two sloping studs bearing against two surfaces in the piston, pushes the breech-piece tight home, and the gun is fired in the usual way. There is a feature in this breech-loader rifle which I do not think exists in any other, it is, that the breech-piece can be taken off and entirely removed from the rifle. You can pull the breech-piece out and put it into your pocket, and make your rifle a present to your enemy, and it will be of no use to him. I have seen no other rifle which possesses this great advantage; indeed, in this respect it has a superlative advantage over all others: the breech-piece can be inserted, and can be pulled out with equal rapidity. The rifle cannot be fired unless the finger-piece is turned down to its proper place. The reason is this: when the lever is turned down, there is a small hole in the bottom part of the plug which goes over a pin. The pin is worked by the trigger, and fits into the hole of the plug. When the lever is not turned down,

* Terry's breech-loader having been referred to at a previous meeting, it has been thought desirable to insert it, for the sake of comparison, &c., in the plate of breech-loaders referred to in this discussion, it is given in Figs. 11—14.—ED.

the hole is turned on one side, and the pin which is in connection with the trigger is brought against the solid part of the plug, and the piece will not go off; but as soon as the lever is brought down, the piece goes off. That is Green's breech-loader. I shot with it myself last week at Kilburn; I fired eight rounds from it at 400 yards; and out of eight shots, I made six bulls'-eyes and two centres.

Captain BURSLEM: I believe the idea of the Government, with respect to the metallic ammunition for a breech-loading rifle, is that the copper cases carrying their own fulminate are liable to explode. I have had a breech-loading rifle since 1860; it has been half over the world with me, and I have never found the ammunition explode. I think if the Government were to try it in any way they like, they would find that those cartridges are not more liable to explosions than others.

The CHAIRMAN: I am at a loss to conceive what real objection there can be to breech-loading. It is strange that those who recommended the adoption of breech-loading to cannon almost to the exclusion of every other description of gun, should have hesitated about adopting it to musketry. There are just ten reasons to one in favour of a breech-loading musket over a breech-loading cannon. The breech-loading cannon is only of value on certain occasions, where it is fired on the non-recoil principle. Now, the argument that is adduced, or professedly brought forward, against the breech-loader is, that it will lead to a waste of ammunition. Rightly viewed, I believe it is the very reverse of the fact. It is the nervous excitability increased by the fear that you are not loading fast enough when you are ramming home and putting the cap on, which all people feel when they enter into action for the first time, and the excitement arising from success or partial failure, which in my opinion leads to the useless waste of ammunition. But if a man is sure of his gun, if he is sure of everything concerning it, he can put in his charge just at the right time, and have it ready for action at the very moment he wants it; he will be comparatively calm, and can use his gun to advantage; his mind will not be upset by the excitement of haste and uncertainty. I quite concur with the General's remarks about the Whitworth and Lancaster rifling. I do not see how, with Westley Richards' form of breech-loader, you are to use it effectually with that description of rifling. With the peculiar motion of turning down that he has, with the polygonal form of rifle in one case, and the oval form in the other, you would not have a perfect junction, and there would be an escape of gas; whereas in the other description, where it goes home, there you might have a perfect fit. I do not see how the two can be combined.

General BOILEAU: There is one point I omitted to explain, which is the peculiarity of this plug of Mr. Green's. The fore-part of the plug is finished by a solid disc. The plug is bored, and there is an axis which fits into it, which is finished also with another solid disc. Intermediate between these two Mr. Green places a wad of mixed gutta-percha and vulcanised india-rubber. He found that the rubber itself was too soft, and the gutta-percha probably too brittle. With a mixture of the two he has succeeded in obtaining just sufficient elasticity and resisting power to secure the desired object. When the cartridge is ignited, the powder acting, of course, in both directions, before it has had time to start the bullet has compressed this disc slightly, has squeezed out, so to speak, a portion of the wad all round it, by rendering it thinner; and by that means has most perfectly and effectively rendered the breech gas-tight. I fired fifty-five rounds with another of Mr. Green's rifles at Kilburn, twenty-five from the muzzle and thirty from the breech, to try whether it would act as well as a muzzle as a breech-loader; and after the fifty-fifth round, when we drew the plug out, the breech chamber was as clean and bright, and as free from the fouling which smoke produces, as if it had never been fired at all. That is an unanswerable proof that the apparatus is perfectly gas-tight. Then, it has another advantage, and that is its perfect applicability to the whole of the Government rifles now in store, the long Enfield, the short Enfield, navy, and carbine. In fact, Mr. Green has fitted his breech-loading apparatus to six different forms of rifles for the Government. They are now under trial at Woolwich. The result with the long Enfield is decidedly good. The only point in which he has not succeeded is the construction of the cartridge. The 0·550 small-bore windage bullet does not suit the breech-loader; it does not suit the Lancaster; but the larger-sized bullet, the 0·570 bullet, answers admirably. With the navy five-grooved rifle I had not that

difficulty with the 0·550 bullet, but still the 0·570 bullet gave much better results. There is another rifle which I may bring to your notice, which is commonly called the Mont Storm rifle (Figs. 21—23). The mechanism of this is exceedingly good, and it has its advocates. I do not myself approve of it. I think where you commence your operation by counter-marching, as it were, the breech, where you insert your cartridge tail foremost, your soldier in the heat of action will be apt to make a mistake. Without reasoning upon the mode in which the bullet should go, I think the first impulse of the soldier is to put in the cartridge, bullet foremost. Without wishing to speak therefore but in praise of the beautiful work and mechanism of this rifle, I think that is a wrong point in its design—that the soldier is to be taught to put the bullet in the wrong way, in order to make it go out the right way. There is another objection to this, as in the case of the Westley Richards' rifle, although there the action of the slide to a certain extent does away with the objection. To bring two bearing surfaces into perfect contact, where they move upon a hinge axis, and where the motion is circular, there must be a wear; and where there is a wear there must be an escape of gas. On that account I think the hinge principle is bad for breech-loaders. Therefore, I prefer the plug principle of Mr. Green, which is simple, cheap, and effective, and which must command attention. I have no doubt that before many months are over we shall see something done. But there is another point connected with breech-loaders which I think is very likely to exercise an important influence, both upon the design and upon the weight of the piece, and that is the introduction of gun-cotton. A portion of the weight of the rifle, as it is now manufactured, has become necessary, from the great recoil which gunpowder produces; there is a necessity, therefore, for making the piece of a certain weight to resist that recoil. But with gun-cotton there is comparatively very little recoil, not a fourth part in some cases of the recoil produced by gunpowder. Therefore, I believe it will be possible to reduce the weight of the piece very considerably without in any way destroying its efficiency, should gun-cotton be introduced as the explosive agent for small arms. General Sabine, with whom I have had a conversation on the subject, is of opinion that breech-loaders will ultimately force their way into notice, and become the weapon of the soldier, as well as the form of artillery; that they are so peculiarly suited to gun-cotton, where there is no smoke and no recoil, that they must command attention, and will ultimately force themselves on the notice of our not very fast, though, I believe, very sure Government.

The CHAIRMAN: You will allow me to record our thanks to the officer who sent us the first paper. Although not so important as the second, it is a very important and interesting paper. The comfort of the soldier is a very important thing, because in the field it is a large element in his efficiency. We also return our thanks to the gentleman who sent the second very interesting and very valuable paper. It is a remarkable paper for a young man to produce. He seems to have a genius for his profession, and to take a practical view of the subject. And it is a practical view that we want, for in the present day transcendentalism has taken the place of practice. And though last, not least, I am sure you will return your thanks to our friend General Boileau for the very luminous instruction and explanation he has given with respect to breech-loaders. I may make a remark with reference to his closing observation as to the curious anomaly it appears to be that gun-cotton has no recoil. I heard an explanation offered for it: it was simply this, that there was no residuum from gun-cotton; while there is about 75 per cent. from gunpowder, which is left as practically as another bullet which is projected backwards; while the lead bullet is projected forwards, this 75 per cent of residuum is projected backwards, and is the cause of that recoil. I give it to you as I got it.

General BOILEAU: I am very much obliged to you for the kind way in which you have received the paper this evening, and for the favourable remarks which you have made upon the efforts that I have made to give it the weight which I think it justly merits.

*ADDENDUM TO "BREECH-LOADERS FOR THE ARMY:" BEING REMARKS ON THE RESULT OF THE AGITATION OF THE BREECH-LOADER QUESTION, AND CONCERNING THE INTRODUCTION OF GUN-COTTON INTO MODERN WARFARE.

By Arthur Walker, Esq., Lieutenant 79th Highlanders; Lieutenant Instructor School of Musketry, Fleetwood.

In these days of railways and electricity, which seem to lend to modern men a reflex of their promptitude, celerity, and decision in all their doings, events succeed each other so thick and fast, that even the steam printing machine can hardly keep pace with their rapid march. The foregoing paper, and the remarks it elicited at the Royal United Service Institution, had scarcely been consigned to the press and given to the public, when the arguments therein contained received a flattering endorsement from the military authorities, the theoretical conviction on their part having been followed by a prompt determination to give it effect in practice.

In fact, so much had transpired in a variety of ways on the subject of breech-loaders, during the last year or two, that the feelings of the country were becoming fairly roused, and the public mind was fast approaching the point of demanding that the army should have the benefit of the undoubted superiority of breech-loaders over muzzle-loaders, when, with prescient sagacity and meritorious promptitude, Lord de Grey and Ripon forestalled any such pressure from without by taking action in the matter himself.

He decided to submit the question in its integrity to the thorough investigation of a competent military tribunal, composed of seven officers,† whose high standing and varied experience on the subject afforded an excellent guarantee for the soundness of their judgment and the propriety of their decision.

This committee assembled on four occasions, and after examining a number of witnesses, it arrived at the unanimous conclusion that it was advisable to arm the whole of our infantry with breech-loading rifles.

Beyond this emphatic recommendation nothing was done in the

* Contributed in September, 1864.—Ed.

† The following are the officers of the Committee referred to:—Major-General David Russell, C.B., President; Colonel Thomas Steele, C.B., late of the Coldstream Guards; Colonel The Earl of Longford, K.C.B.; Colonel Clarke Kennedy, C.B., Commandant of the Military Train; Colonel Parke, C.B., Commandant at the Fleetwood School of Musketry; Colonel Adye, C.B., Royal Artillery; and Colonel Walker, C.B., formerly of the 2nd Dragoon Guards, and now Assistant Quarter-Master-General of the South-Eastern District.

way of detail, except that attention was directed—in the event of the decision of the committee being adopted—to the necessity of a more efficient service for the transport of the first reserve of ammunition; and of such importance was this considered by the authorities, that another special committee has since been appointed, with the view of examining the suggestion made on this head by the former.

The first reserve of ammunition should, obviously, be made to accompany soldiers whithersoever they may have to go—whether along the path of a mountain-defile, or in making a flanking detour across a river by a bridge of planks or boats. To convey this supply, pack-mules or horses (but the former are much to be preferred) should be substituted for the present system of cartage on service; or perhaps some description of handcart, or tumbril, on wheels, could be devised, so light and portable as to permit of its being easily moved along by one or more men, and capable, on occasions, even of being transported on their shoulders. A certain number of extra men would have to be told off for these tumbrils and to supply the pouches from them. At present each brigade carries its own ammunition, but with a breech-loader, that can be fired five or six times as often as a muzzle-loader, it will be absolutely necessary that every *company* in a *regiment* should have its proper quota of ammunition transport attached to it, just as it now has its quota of pioneers and buglers, the reserve ammunition for the *brigade* and the *division* being kept quite distinct.

Some such provision is absolutely necessary; but we are inclined to think that even more attention and consideration in this matter should be given to the soldier himself, with respect to the load of ammunition which he has to carry. It is generally becoming evident that the day has gone by for heavy-weighted soldiers; and the prevailing opinion is that a kit of over 50lbs. weight is rather too much for our modern soldier, or rather rifleman-sharpshooter, whose salient characteristic must be the utmost agility, promoted in every way by convenient equipment, in order to meet the sudden requirements which will be necessitated in future warfare, wherein if anything be certain, it is that victory will depend upon the accurate *coup d'œil* of the leader in deciding upon action, and the promptitude with which his soldiers can carry out his object.

Heavy, massive, unwieldy regiments are as obsolete as Frederick William's Patagonian Grenadiers: the days of old when battalions leisurely advanced, till they could distinguish the whites of their enemy's eyes before opening fire, are now long past; the deadly missile begins to pour in at a distance at which even the sound of its discharge is inaudible, and the foe himself appears little more than a thin dark line upon the landscape. To advance now "very slowly," (*fort lentement*), as Todleben, *the* hero of the Crimea, describes our troops to have done at the Alma, towards an enemy's breast-works, in the face of rifled guns and troops provided with breech-loaders, would only be equivalent to advancing "into the jaws of death."

We must apply the Banting-system, as it were, to our heavy-booted, over-fed, and over-clad Grenadiers, for depend upon it, it is your light-footed, clear-eyed youth, breech-loader in hand, with open collar and

no 50lb. knapsack to drag him to the earth—like a race-horse over handicapped—who will turn the tide of future battles.

Let us imitate the "loose order" and rapid concentration of the battle of Solferino, rather than perpetuate that tardiness of movement which cost us so much in the Crimea, both in men and reputation.

Obviously, therefore, the strength of the soldier must no longer be wasted in doing the work of a travelling packman, or rather a pack-horse, but, on the contrary, husbanded for the work for which he is specially intended. With this view, the weight of his kit should be reduced, and his dress modified, so as to permit him to carry some thirty or forty rounds more of ammunition.* After victory plenty of kit haberdashery can be got for the mere seeking; but ammunition is to be procured only from one shop, and that may be very far away.

The Prussians have already adopted this system; they carry *in front* two ammunition pouches, capable of holding some thirty rounds each, whilst they carry another thirty rounds by way of reserve in their knapsacks.

It seems strange that the present lumbering cartouch-box, misnamed a "pouch," with its awkward position *in rear* of the back, is still retained to hamper and incommode the modern soldier, whose work will be very different to that which was performed by those that used it in the last and preceding century.

Another Committee has likewise been appointed *to give effect* to the recommendation of the first, as to the adoption in our army of breech-loaders, or, in other words, to determine the very important and difficult question—WHICH BREECH-LOADER shall be put into the hands of the British soldier?

Pending, however, the decision,—which it will obviously require some time to make, and still longer to give effect to in the shape of a new armament,—it appears that Lord De Grey contemplates the "conversion," or, as the French call it, the "transformation" of a number of Enfield rifles into breech-loaders; and has actually advertised for the best means of doing so, under the condition that the cost per rifle should not exceed £1, and that the shooting of the transformed weapon should not be inferior to that of the unaltered arm, awarding at the same time to each competitor £20 as compensation for the cost of pattern, together with one thousand rounds of ammunition suited for the arm so converted. No doubt this can be done; indeed the problem has in a manner been already solved in the Mont-

* In a letter to the "Times" (28th December, 1860), on "Military Organization," the author pointed out this necessity, and suggested means by which the necessary reform could be effected without increasing the *impedimenta* of an army to any material extent.

A letter by an Englishman in the service of the Confederate States appeared the other day (in the "Times"), in which the writer, after cleverly expatiating on the advantages of breech-loaders, and the fact that the Confederates, as fast as they captured rifles in the field, converted them into breech-loaders, states his opinion that the 60th Rifles, if armed with breech-loaders, could destroy the brigade of Guards in fifteen minutes, little knowing that as at present constituted, and armed with the Whitworth rifle, the 60th actually carry more weight, man for man, than either a Guardsman or a Linesman. So much for our *heavy* (pseudo) "Light" Infantry.

Storm rifle (the great objection to which, we may remark parenthetically, consists in having the hinge of the breech-piece *in front* of the charge, vide Figs. 21—23), and there are, we believe, some dozen other known designs for the desired conversion.

In thus attempting to utilize the rifle we have, Lord de Grey is doubtless actuated, first, by reasons of an economical kind, and, secondly, by his desire to supply the army *at once* with a breech-loader, even though in the shape of a makeshift, pending the discovery of a more perfect form of breech-loading rifle. But while doing full justice to his motives in taking such a step, we are inclined to doubt its wisdom. Makeshifts are bad at the best, as sportsmen and riflemen well know; and a makeshift on which the prestige and safety of the empire may depend would be worse than all.

There are numerous serious objections to it. The expense of the conversion will of course ultimately have to be added to the cost of new breech-loaders for the army, so that in this sense it may be said to be "penny wise and pound foolish." Again, even at the best, an Enfield Rifle does not last longer than ten years; but in reality its life as a *rifle* is much shorter: so that in seeking to adapt a breech-loading system to it may be said to be "throwing good money after bad." The weapon has been condemned by an Ordnance Select Committee, and to all intents and purposes it cannot bear comparison, as a military weapon, with others with which it was tested by the Committee in question. Its day is gone; its glass is run; let it rest in peace; having done what it could in one stage of its existence, let us not vainly torture it into a metamorphosis, to which all the heathen gods together could not give congruity. "New wine in old bottles" would be nothing to the idea of turning the present condemned Enfield into the Enfield of the future.

Again, it will be a difficult matter, at the rate per rifle stipulated, so to alter the rifle as to dispense with the percussion-cap system, on the manifold disadvantages of which we have enlarged; and, finally, by retaining the Enfield-bore we sacrifice one of the great gains secured by the breech-loading rifle, namely, that a very small bore may be used, with its concomitant advantages of increased range, penetration, and accuracy, *without* any of the disadvantages which the use of a smaller calibre than ·50 in. involves in a muzzle-loader in the shape of difficulty in loading and accumulation of fouling, &c.

This is a point which appears to have been entirely lost sight of by Major-General Boileau in his remarks at page 406, as to the applicability of the Whitworth or Lancaster small-bore to a military breech-loader. Indeed what he there doubts as feasible has actually been accomplished; for, as everybody knows, the Westley Richards' breech-loader has a barrel on the Whitworth principle; indeed it is patented as such.

It is not a little mortifying to our national pride to hear on all occasions of this kind the reiterated remark that they manage these matters differently and better across the Channel; but better this than that we should delude ourselves into a vain notion of superiority in such matters. For several years past experimental breech-loaders

have been tried and tested at the great school of musketry at Vincennes; and in the weapon and ammunition recently served out to the Cent Gardes, the French Emperor appears to have found a breech-loader with which he is satisfied, and so we find that the other morning an imperial order made its appearance, in which it is decreed that *the whole* of the army of France will henceforward be furnished with a small-bore breech-loader (·30, we understand, is the calibre), the cartridge to contain its own ignition.

There is no compromise here—no half-measure. France has had enough of musket-"transformation," and found it a very sorry makeshift; and so the chances are now that the greater portion of the French army will be supplied with breech-loading rifles of surprising efficiency, before we have even commenced the transformation of what the volunteers—perhaps too disparagingly—term "a gas-pipe."

Would it not be well for us to follow so good an example, and instead of tinkering up our old barrels with new breech-pieces, rather at once discontinue the further manufacture of the muzzle-loading Enfield (at present going on as fast as ever), and direct at once our energies and resources to the construction of a good breech-loader, to be served out gradually to the army as the present arm wears out, or as fast as the new arm is ready to relegate the old one to the ranks of the Militia or Volunteer forces?

Be this as it may, however, the momentous question for our service still remains to be answered—*which breech-loader* shall we adopt?

The elucidation of this matter will doubtless occupy the Ordnance Committee for many months (*query*, years?) to come, unless, indeed, the National Rifle Association come to their assistance and settle the matter off-hand.

We may be permitted in the meanwhile to say, that we cannot see why the Association should at all continue the custom of having a competition for *muzzle-loading rifles*—as it proposes, we observe, for November next—under the present circumstances of the universally admitted breech-loading superiority, and since the British army is to be furnished with breech-loaders. It appears to us that the Association might just as well endeavour to elicit the best *long bow* as the best muzzle-loader now, for all purposes of practical utility.

In this breathless age it seems almost like plunging into antiquity to recall the late Wimbledon gathering, yet we must refer here, however briefly, to what undoubtedly formed the most important portion of the programme at that meeting, we mean of course the competition for the prize of £100, given by the Marquis of Tweeddale, for military rifles carrying ·550 ammunition. With a view of attracting the best weapons in either class the money offered was divided as follows:—£50 open to muzzle-loaders, and £50 open to breech-loaders. The conditions under which the contest took place were well calculated to test the qualification of the respective rifles, the stipulation being that each competitor was to fire 100 rounds continuously on four successive days, at 500 yards, until 400 rounds should be expended,—at the termination of each day's shooting the rifle being locked up without having been cleaned, so as to test its shooting under all circumstances

—not merely when fresh from the factory, with every advantage in its favour—thus to demonstrate whether it would bear up against the disadvantages of active service with equal efficiency.

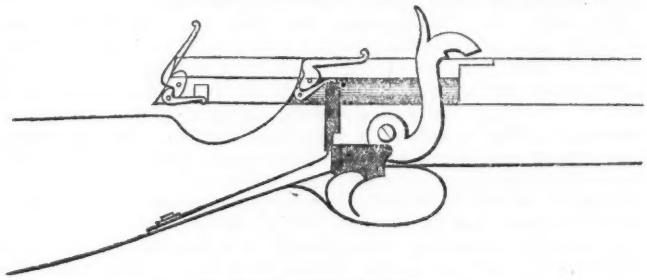
The prize for muzzle-loaders was won by a short large-bore Whitworth, which accomplished the following surprising and marvellous results:—Out of the 400 shots fired on four different days, 1,162 marks were scored, or only 38 marks less than an average of centres. The time occupied in making this splendid practice was 103 minutes, or within a fraction of 4 shots per minute. As this striking and insurmountable evidence of what can be done with a muzzle-loader is certain to be adduced in argument whenever the comparative merits of muzzle and breech-loaders are discussed in future, it is right to state that in the handling of Mr. Whitworth's rifle, the time occupied in loading was reduced to a *minimum* by the use of cartridges specially prepared. These were of a similar description to those patented for use with his small-bore rifle, save that they were made of the regulation size. A paper cylinder contains both the powder and bullet in the order in which these are to descend into the barrel. The bullet acts as a plug at one end of the cylinder; at the other the powder is confined by a little calico and pasteboard slide, which can be pulled away the moment the cartridge case is placed on the top of the barrel. A single downward motion of the ramrod through the cylinder sends the bullet home after the powder; the cartridge case then slips off over the head of the ramrod, and this there is never any occasion to turn, because the point, hollowed slightly into the shape of a cup, gives all the force that is necessary to the charge in ramming home, and immediately that the rod is withdrawn from the barrel it is in the right position to be thrust into the stock.

Mr. Whitworth was also fortunate in his representative Mr. Leece, whose steadiness, quickness, and confidence of aim were very remarkable. This explanation does not involve any disparagement of Mr. Whitworth's rifle. On the contrary, it shows, that having made up his mind to forward what he believed to be the best weapon, he took care to surround it with the best appliances; it proved the great practical utility of such competitions, and elicited the fact that we had much to learn even as to muzzle-loaders. However, their *rivals* and successors *in esse* are what most concerns us on the present occasion, and we therefore turn to the results of the *breech-loading* competition.

The rifle that won that prize was made by Mr. Henry, gunmaker, of Edinburgh. Its mechanism may be briefly described as follows: the breech (upper part) acts as a plunger, the back part of it having a double eccentric lever, whilst the front part has a peculiarly inclined face, formed out of the solid steel, which *rights* the position of the cartridge, carries it into the chamber of the barrel, and also extracts the empty cartridge-case on being opened again, and draws it out altogether.

The actual result of its practice on this occasion may be summed up as follows:—In the 400 rounds fired, 1,080 marks or points were made in 68 minutes 32 seconds, giving a value to each shot of 2·7

points, and a rate per minute of 5·84, or nearly 6 shots, which is half the rapidity of the long-bow of our ancient British archers.



THE HENRY BREECH-LOADER.

In awarding the prize to Mr. Henry, the Council took occasion to remark that they did not, however, consider that this breech-loader met all the requirements of a military arm, and this is their reason for initiating with liberal foresight another contest for arms on this principle, the best arm to have £100, the competition to take place next February.

The breech-loader which came next to Henry's in point of merit, appears to have been one called the Snider rifle, closely resembling in principle the Prussian needle-gun. It exceeded the Henry rifle in rapidity of loading, but fell far short of it in point of accuracy.

In conclusion, we have only to remark that the only real difficulty remaining to be overcome in the development of a thoroughly efficient breech-loader for military purposes is in the cartridge itself, the best ammunition being almost a harder problem than the best arm. Those who use breech-loaders over the stubble, or in the forest, have, of course, over and over again congratulated themselves on having at length obtained a cartridge which entirely does away with the "bother of caps." Hitherto, as we have already mentioned, the authorities have studiously (for prudential reasons, no doubt) set their face against the use in the army of a cartridge which shall combine such elements of danger as the presence of the percussion powder, as well as that of the villainous saltpetre. It is obvious that the brass pin which stands out at the right angles of the cartridge (in the Henry breech-loader and in the cartridge for breech-loading fowling-pieces in general), and the blow on which causes the ignition of the fulminating powder, would be extremely likely to be bent from its position, or forced out altogether in the rough handling to which it would be subjected in a campaign.

In the American invention, to which we have referred at page 405, it seems this obstacle of facile derangement is completely obviated. The cartridge is to all appearance similar to that in ordinary use (with sporting breech-loaders), save that it is without the "pin." But a slight beading runs round the circumference of the copper capsule,

which forms the base of the cartridge, and the inside of this rim or periphery is lined with a paste of the fulminating powder, and thus the hammer especially formed for the purpose, striking it through the aperture in the barrel where the pin would have otherwise protruded, on any portion of its surface, will ignite the charge. The likelihood of the derangement referred to above is thus remedied, and there is a minor difficulty (but still a difficulty) also superseded—that of its being necessary to insert the cartridge into the barrel with the pin accurately fitting the groove prepared for it. There is also another advantage claimed for this cartridge. It is asserted that nothing but the peculiar action of the hammer will ignite it. A number of them have been shaken violently together, struck, and thrown down with force on stones, and generally subjected to an elaborate course of rough treatment, with the determined intention of accomplishing their explosion, but all to no purpose. The inventors explain that to do so requires a squeeze as well as a sharp blow, and that, unless the cartridges be inserted in a close-fitting barrel, their elasticity preserves them from the combination of the two.

They are professedly water-tight, and impervious to fire. I have certainly seem some, round which gunpowder has been exploded, apparently quite uninjured.

Mr. Westley Richards, who, by the way, did not enter into the competition for the Marquis of Tweeddale's prize, is engaged, at the request of the Government, in making a breech-loading arm, with a cartridge to contain its own ignition, although he does not appear to be very sanguine as to the result, on account of the expense of the copper case, and the difficulty of extracting such a cartridge after firing from the *small-bore* rifle.

For our own part, we are inclined to believe that this difficulty will eventually find its solution in that wonderful material gun-cotton, 1 drachm of which is capable of effecting as much as 3 drachms of gunpowder, and that too with far less recoil, and a perfect immunity from smoke and fouling.

Experiments made by the Austrian committee proved that 100 rounds could be fired with gun-cotton, against 30 rounds of gunpowder. From the low temperature produced by gun-cotton, the gun does not heat. Experiments showed that 100 rounds were fired with a 6-pounder in 34 minutes, and the gun was raised by gun-cotton to only 122° Fahrenheit, whilst 100 rounds with gunpowder took 100 minutes, and raised the temperature to such a degree that water was instantly evaporated, therefore considerably above the boiling point, or 212°. The firing with the gunpowder was, therefore, discontinued; but the rapid firing with the gun-cotton was continued up to 180 rounds, without any inconvenience. The absence of fouling allows all the mechanism of a gun to have much more exactness than where allowance must be made for fouling. The absence of smoke promotes rapid firing and correct aim. There are no poisonous gases, and the men suffer less inconvenience from firing in casemates, under hatches, or in closed chambers. The fact of smaller recoil from a gun charged with gun-cotton is established by direct experi-

ment; its value is *two-thirds* of the recoil from gunpowder—projectile effect being equal. To understand this may not be easy, unless it results from the greater rapidity of its entire ignition; whilst that of gunpowder, strictly speaking, takes time, the ignition of gun-cotton is instantaneous throughout the mass, and the known causes of recoil with gunpowder are modified accordingly.

The great fact of the instantaneous ignition of gun-cotton, and the generation of all the gas, *before motion commences*, are, it seems, sufficient to account for diminished recoil in the piece.

The comparative advantages of gun-cotton and gunpowder for producing high velocities are shown in the following experiment with a Krupp's cast-steel gun, a 6-pounder. With the ordinary charge, 30 ounces of powder produced 1,338 feet per second. With the charge of 13½ ounces, gun-cotton produced 1,563 feet. The gun may be made shorter; less weight, therefore, to drag, and less difficulty in the working. As to the advantage in weight of gun, the fact of the recoil being less in the ratio of 2 to 3, enables a less weight of gun to be employed, as well as a shorter gun, without the disadvantage to practice arising from lightness of gun.

As regards durance of gun, bronze and cast-iron guns have been fired 1,000 rounds without in the least affecting the endurance of the gun.

As regards conveyance and storage of gun-cotton, it results from the fact that 1lb. of gun-cotton produces an effect exceeding 3lbs. of gunpowder in artillery, that the difficulty of transport will be diminished, and much less room will be required for ammunition. This is an immense advantage, whether it is carried by men, by horses, or in waggons.

It may be placed in store, and preserved with great safety. The danger from explosion does not arise until it is actually *confined* in the requisite space.

It may become damp, and even perfectly wet without injury, and may be dried by mere exposure to the air. This is of great value in ships of war—in case of danger from fire, the magazine may actually be submerged, without permanent injury to the ammunition.

Gun-cotton positively keeps the gun clean, and requires less windage, and therefore performs better in continuous firing. In gunpowder there is 68 per cent. of refuse, or the well-known matter of fouling. In gun-cotton there is no residuum, and therefore no fouling, so that the present elaborate instruction in "cleaning arms" will be at once reduced to a *minimum*, if not annihilated so far as the rifle-barrel is concerned.

Each gun and each kind of projectile requires a certain density of cartridge. Practically, gun-cotton is most effective in guns when used as one-fourth to one-fifth of gunpowder, and occupying a space of $1\frac{1}{10}$ of the length of the powder cartridge.

The mechanical structure of the cartridge is of importance as affecting ignition. The cartridge is formed of a mechanical arrangement of spun cords, and the distribution of these, the place and manner of ignition, the form and proportion of the cartridge, all affect the time of complete ignition. As a cartridge, gun-cotton has to be enclosed in

a manner to prevent its compression, and give it a certain amount of space to do its work. Indeed its gradual instead of instantaneous combustion is altogether dependent on this point being attended to, for whereas the running down or compression within certain limits of gunpowder is essential to its effective action, any such process is fatal to that of gun-cotton, in other words gun-cotton must be simply transferred to the breech of the gun, so as to retain its normal formation or natural degree of textile expansion.

For this purpose, the cartridge, or muzzle-loaders, can either be made up in a strong, hard pasteboard tube, so as to prevent its compression; or the simple cotton-yarn may be wound round a thin-hollow wooden tube like thread on a bobbin, with a sufficient cylindrical thickness to fill the chamber of the gun.

The drawback to this is, as was found during experiments with gun-cotton at Hythe, that the charred remnant of the wood or paper is apt to remain in the barrel, to the detriment and danger of subsequent firing.

The necessity for maintaining the gun-cotton spread out or expanded to the full room it requires, which acts so awkwardly and disadvantageously in a muzzle-loader, becomes of little or no consequence in a breech-loader, in which the chamber intended for the reception of the charge can be so arranged as to permit the gun-cotton to be placed quietly in its appropriate receptacle, without being further interfered with till the moment of final discharge. It is by the complete mastery he has gained over all these minute points, that General von Lenk is enabled to give to the action of gun-cotton on the projectile, any law of force he pleases.

Finally, its cost of production is considerably less than that of gunpowder, the price of quantities which will produce equal effects being compared.

Having thus stated some of the mechanical properties of gun-cotton as an explosive agent, we cannot do better, in conclusion, than answer the question which will not unnaturally present itself to some readers, viz., what *is* gun-cotton, considered chemically?

Gun-cotton, or pyroxilin (*pyr*, fire, and *xylon*, wood) as it is generically termed, was invented in 1846 by the German chemist Schönbein; and although the announcement produced considerable sensation at the time, it had, until recently, ceased to occupy the minds of those whom the invention chiefly concerned—the military profession. "Punch," indeed, gave significance to it by figuring a meeting between Guy-Fawkes and Schönbein on Westminster Bridge; the former regretting that the latter had not been his contemporary with his invention. Certainly there might have been no "joke" in the matter, at the present day, about "the Plot," had gun-cotton been at the disposal of the arch-conspirator.

The "report," like all other reports, died away; and gun-cotton, far from being generally applied even to mining operations, was merely made the substance of a thick mucilage, dissolved in ether, to serve by way of sticking plaster. Subsequently, however, photography took it in hand, and found its ethereal solution a perfect means of

presenting to light the sensitive surface for the production of its beautiful pictures; for the collodion of the photographers is merely gun-cotton dissolved in sulphuric ether, and mixed with an iodide, which by being immersed in a bath of nitrate of silver, becomes iodide of silver, the most sensitive to light of all substances as yet discovered.

The recent Austrian Commission, and the conclusive investigations of Baron von Lenk, have completely restored to this giant of the chemist's laboratory its "proud eminence;" and, like gunpowder of old, after having been used for every purpose but the right one, in our *professional* point of view, it now finds itself exalted to the position of the most available agent for the purposes of warfare.

The manufacture of gun-cotton is one of the simplest manipulations of the laboratory. First, make a mixture of equal measures of strong nitric acid (sp. gr. 1·5), and sulphuric acid (sp. gr. 1·845). Then take one part—say 1 oz.—of finely carded cotton-wool, and immerse it in 15 parts of the above mixture. Instantly great heat is generated by the chemical action which ensues, and therefore this is the ticklish point of the manufacture. The cotton must be at once completely immersed in the mixture, otherwise it becomes so hot as to undergo immediate decomposition.

After a few minutes' immersion, the cotton must be taken out and plunged into a large volume of cold water, and then carefully washed in other water, until the mass ceases to show the slightest acid re-action when touched by litmus paper or placed upon it. It must then be carefully dried. Of course it will dry of itself in the air; but at all events, if artificial heat be used for the purpose, it must not exceed 170°.

Such is gun-cotton; and it is evident to the reader that it contains all the elements of gunpowder; the *nitre* of the nitric acid. the *sulphur* of the sulphuric acid, and the *carbon* (or "charcoal") of the cotton; its explosive or detonating property can therefore be readily conceived.

Tow, linen, paper, nay, even *saw-dust*, may be used instead of cotton; and in the last case it is evident that gun-cotton might be made to assume the form of *powder*, and so perhaps become more convenient for military purposes. The wood best suited for the manufacture of gunpowder might be treated in this way with the view of testing the feasibility of the suggestion, which we submit to the manufacturers.

The chemical change develops new properties in the substance; the cotton fibre increases more than 80 per cent. in weight; although differing very little in appearance from unchanged cotton, it may be distinguished from it by its harshness to the touch, by the crepitating sound which it yields when pressed by the hand, and by its *electric* condition. The only certain means, however, of distinguishing the explosive substance from ordinary cotton, is by the chemical action of iodine dissolved in a solution of iodide of potassium. When the former is moistened with this iodine solution, and a little sulphuric acid is subsequently added (one part of acid to four of water), a *yellow*

colour is evolved; whilst ordinary cotton, when similarly treated, assumes a *blue* colour.

In the open air gun-cotton burns with a flash, but without smoke or report; and a temperature of somewhat less than 400° is sufficient to ignite it, being 200° less than that required to ignite gunpowder. Authorities, however, differ very much as to the required temperature, which seems to vary with the mode in which the gun-cotton is prepared. Some specimens have exploded when being dried at a temperature of not more than 132°.

Up to the publication of the Austrian Report, the real properties and effects of gun-cotton were little understood. It can be exploded in any quantity instantaneously. This was considered its great fault; but it was only a fault when we were ignorant of the means to make that velocity anything we pleased. General von Lenk has discovered the means of giving gun-cotton any velocity of explosion that is required, by the mere mechanical arrangements under which it is used. In his hands, gun-cotton has any speed of explosion; from one foot per second, to one foot in the *one-thousandth* of a second, or to instantaneity.

The instantaneous explosion of a large quantity of gun-cotton is made use of when it is required to produce destructive effects on the surrounding material. The slow combustion is used when it is required to produce manageable power, as in the case of gunnery.

It is plain, therefore, that if we can explode a large mass instantaneously, we get out of the gases so exploded the greatest possible power, because all the gas is generated *before motion commences;* and this is known to be the condition for maximum effect. The great waste of gunpowder is almost ridiculous; it is positively 68 per cent. of its own weight, and only 32 per cent. is useful. Moreover, this 68 per cent. is not only waste in itself, but it wastes the power of the remaining 32 per cent. It wastes it mechanically, by using up a large portion of the mechanical force of the useful gases. The waste of gunpowder issues from the gun with much greater velocity than the projectile; and if it be remembered that in 100lbs. of useful gunpowder, this is 68lbs., it will appear that the gas of 32lbs. of useful gunpowder is wasted in impelling a 68lb. shot; the power resulting merely from the refuse of gunpowder!

It is found that the condition necessary in gun-cotton to produce instantaneous and complete explosion, is the absolute perfection of closeness in the chamber containing the material. The reason of it is, that the first-ignited gases must penetrate the whole mass of the cotton; and this they certainly do, and effect complete ignition throughout, only *under pressure*. This pressure need not be great. For example, a barrel of gun-cotton will produce little effect, and very slow combustion, when out of the barrel, but instantaneous and powerful explosion when shut up within it.

On the other hand, if we desire gun-cotton to produce mechanical work, and not the destruction of materials, we must provide for its slower combustion. It must be distributed and opened out mechanically, so as to occupy a larger space, and in this state it can be made to act

even more slowly than gunpowder, and the exact limit for purposes of artillery General von Lenk has discovered by critical experiments. In general it is found that the proportion of 11lbs. of gun-cotton, occupying one cubic foot of space, produces a greater force than gunpowder, of which from 50 to 60lbs. occupies the same space, and a force of the nature required for ordinary artillery.

For artillery, gun-cotton is used in the form of thread or spun-yarn. In this simple form it conducts combustion slowly in the open air, at a rate of not more than one foot per second. This thread is woven into a texture or circular web. The webs are made of various diameters, and it is out of these webs that common rifle cartridges are made, merely by cutting them into proper lengths, and inclosing them in stiff cylinders of pasteboard, which form the cartridges. In this shape its combustion takes place at the speed of 10 feet per second.

In these cylindrical webs it is also used to fill explosive shells, as it can be conveniently employed in this shape to pass through the neck of the shell.

Gun-cotton thread is spun into ropes in the usual way up to two inches in diameter, hollow in the centre. This is the form used for blasting and mining purposes; it combines great density with speedy explosion.

The gun-cotton yarn is used directly to form cartridges for large guns by being wound round a bobbin so as to form a spindle, like that used in spinning-mills. The bobbin is a hollow tube of paper or wood. The object of the wooden tube is to secure in all cases the necessary length of chamber in the gun required for the most effective explosion. The gun-cotton circular web is inclosed in close tubes of india-rubber cloth, to form a match line, in which form it is most convenient, and travels with speed and certainty. In large quantities, for the explosion of mines, it is used in the form of rope, and in this form it is conveniently coiled in casks, or stowed in boxes.

As regards the practical application of gun-cotton to the destructive explosion of shells, it appears that, from a difference in the law of expansion, arising probably from the pressure of water in intensely heated steam, there is an extraordinary difference of result, namely, that the same shell is exploded by the same volume of gas into more than double the number of pieces. This is to be accounted for by the greater velocity of explosion when gun-cotton is confined very closely in very small spaces. It is also a peculiarity that the stronger the shell the smaller the fragments into which it is broken.

In mining operations, the fact that the action of gun-cotton is violent and rapid in exact proportion to the resistance it encounters, tells us the secret of its far higher efficacy in mining than gunpowder. The stronger the rock, the less gun-cotton, comparatively with gunpowder, is necessary for the effect; so much so, that while gun-cotton is stronger than powder as 3 to 1 in artillery, as before stated, it is stronger in the proportion of 6·274 to 1 in a strong and solid rock—weight for weight. It is the hollow rope form that is used for blasting. Its power of splitting up the material is regulated exactly as wished.

With respect to military and submarine explosion, it is a well-

known fact that a bag of gunpowder nailed on the gates of a city will blow them open. In this case gun-cotton would certainly fail; a bag of gun-cotton exploded in the same way is powerless. If one ounce of gunpowder is exploded in scales, the balance is thrown down; with an equal force from gun-cotton nothing happens. But to blow up the gates of a city a very few pounds of gun-cotton, carried in the *hand of a single man*, will be sufficient, only he must know its nature. In a bag it is harmless; exploded in a box it will shatter the gates to atoms. Against the palisades of a fortification a small square box, containing 25 lbs., merely flung down close to it, will open a passage for troops. In actual experiment on palisades, 1 foot in diameter, and 8 ft. high, piled in the ground, backed by a second row of 8 inches diameter, a box of 25 lbs. of gun-cotton cut a clean opening 9 ft. wide. In this case three times the weight of gunpowder produced no effect whatever, except to blacken the piles.

Against bridges it is equally formidable. A strong bridge of oak, 24 feet span, was shattered to atoms by a small box of 25 lbs., laid on its centre. The bridge was not broken, it was literally shivered.

The effects of gun-cotton under water are not less striking and conclusive in its favour, as compared with gunpowder. In the case of two tiers of piles, in water 13 feet deep, 10 inches apart, with stones between them, a barrel of 100 lbs. of gun-cotton, placed 3 feet from the face, and 8 feet under water, made a clean sweep through a radius of 15 feet, and raised the water 200 feet. In Venice, a barrel of 400 lbs., placed near a sloop in 10 feet water, at 18 feet distance, flung it in atoms to a height of 400 feet!

All the experiments made by the Austrian Artillery Commission or Committee were conducted on a grand scale, 36 batteries, 6 and 12-pounders (for gun-cotton) having been constructed and practised with that material. The reports of the Commissioners are all based on trials with ordnance, from 6-pounders to 48-pounders, smooth bore and rifled cannon.

Such then are the properties and effects of gun-cotton. We are aware that exceptions may be taken as to certain parts elicited and claimed as advantages in the new material as an agent in warfare, such as the diminished heat of the gas and the shorter gun required.

Thus we learn in a recent investigation, conducted at the French Academy of Science by M. Pelouze, one of the chemists who wrote a report against gun-cotton in 1849, in conjunction with a M. Maurey, with the view of testing the value of General Lenk's process of manufacturing gun-cotton compared with that in France, that while admitting a difference of chemical composition between the two varieties, they affirm that all their specimens of his cotton exploded at a temperature of 180° Fah., and that at temperatures as low as 99 Fah., decomposition ensued with equal certainty, but only in the course of a few hours, and in one case they even obtained an explosion at 83°, which induced them to "suspect" that it may even be decomposed at the ordinary temperature.* Yet in the face of such a

* This spontaneous decomposition passes through four different stages. At first it contracts slowly without losing its primitive form and texture, so that its volume

conclusion, they admit that General Lenk had been able to fire 1,000 rounds in quick succession from a piece of ordnance without spoiling the bore of the gun, or without any apparent tendency in the gun-cotton to ignite spontaneously from the high temperature to which the gun-metal assuredly must have been raised after so many quick successive discharges. Facts are stubborn things, and if such as have here been quoted can be established by the Austrian Commission, it will be futile to "reason" them away, for, as Galileo says, "when we have the decrees of nature, authority goes for nothing." Preconceived, scientific inductions, based on the action of gunpowder gas, cannot be quoted in opposition to the facts established on gun-cotton.

The expansive and motive force of gunpowder is doubtless materially connected with its heat, but facts seem to prove that this is not a condition so essential in gun-cotton; and the learned objectors should rather try and find out the reason for the apparent anomaly, than preach it as an impossibility, from a text recorded under a different dispensation.

The same remark applies to the shortness of gun required for gun-cotton. Beyond a certain limit, it is certain that length of gun is a disadvantage; and accepting the facts of the Austrian Commission, we do not see that the objection opens any other question than the adequate length of gun for maximum effect.

It is satisfactory to know that at their last meeting (1863) the British Association passed a resolution urging the Government to appoint a commission, by means of which a more complete investigation—and such as the subject unquestionably deserves—may be made and practically applied. This recommendation has not been without its effect, and we rejoice to find that the War Office has appointed a committee on gun-cotton, with the President of the Royal Society as chairman, and that they have instituted a number of experiments, which are to demonstrate the superiority of gun-cotton over gun-

becomes ten times less than its original one. A few days later it becomes soft, and is transformed into a sort of gummy matter which adheres strongly to the fingers, and has no longer any appearance of texture or organization whatever, even when viewed through the microscope. When this mass has become quite homogeneous, its volume is again reduced by one-half. The third stage, which occurs some considerable time after, instead of producing any further contraction, causes an expansion, so that the substance, reduced as it is to one-nineteenth of its original volume, swells up to the full extent of the latter. In this state it is still gummy, but the mass is porous, and full of cavities like a sponge. During these three stages there is a constant evolution of nitrous vapours, which become much more abundant during the third stage. This evolution of gas gradually diminishes during the fourth stage; the substance slowly loses its gummy quality and yellowish colour, and becomes so friable as to admit of being crushed into powder between one's fingers; it then becomes as white as sugar. It takes at least five months to see all these stages passed through. The sugary substance is very acid, nearly entirely soluble in water, and is composed of glucose, gummy substances, oxalic acid, a little formic acid, and another which M. de Luca thinks is new, and with which for the present he has obtained salts of lead and silver. The glucose contained in this last transformation of gun-cotton has the taste and even the flavour of honey; it quickly reduces the tartrate of copper and potash, and ferments in contact with yeast, producing carbonic acid and alcohol. It appears from M. de Luca's experiments that gun-cotton will keep indefinitely in vacuo.

powder, not only for war, but for industrial purposes. The cotton has been tried in one of the mining districts of Wales, and is now undergoing trial in the lead-mines of Allenheads, in Northumberland; while the gun-cotton factory at Stowmarket is kept busy with the manufacture.

Whatever has been done up to this time, it is to be hoped that England will not remain behind-hand in a matter of such great and national importance, for we have no hesitation in maintaining that the introduction of gun-cotton into warfare will effect as great a revolution as that produced by gunpowder of old.

Compared with the latter, in its beginning, gun-cotton is a *perfect* thing, of which we have become possessed—completely meeting all our present difficulties, supplying all our wants, and giving the last perfection to the soldier's weapon. Surely, the high exaltation predicted by Robins of old to "the state that shall thoroughly comprehend the nature and advantages of rifled barrel-pieces, and having facilitated and completed their construction, shall introduce into its service their general use, with a dexterity in the management of them"—is even more applicable to this wonderful invention, which is now offered by science and art to warfare, in order to make it sharp, short, and decisive.

And then? Well, then possibly "the goal of yesterday will be the starting point of to-morrow." The ordinary breech-loader may eventually have to make way for a breech-loading *revolver* (or what the Yankees term "repeater"*), with an indestructible steel rifled-barrel, capable of letting one man do what it before required many more times that number to accomplish, in accordance with the universal tendency of our age to substitute mechanical means for manual.

But for a time, at least, a good breech-loader, with gun-cotton, will be, if not perfection in the fire-arm, the nearest approximation to it we can hope at present to attain. Imagine the future battle-field unclouded with smoke—clear as the hand-to-hand encounters of the ancient warriors, who never lost sight of their enemy. Then, indeed, our tactics will have to be modified, if we are to play our part successfully on the battle-fields of Europe or America—battle-fields which will probably become more bloody than ever.

But we must not permit these facts and hopes held forth by this new agent of destruction to produce any present stagnation in our efforts for advancement; but rather, content with the materials thus far practically placed within our reach,

"Forward! forward let us range!"

* In accounts recently brought from America, it is distinctly stated that some Federal cavalry regiments are armed with *sixteen-shooter* rifles! (equivalent to a sixteen-chambered revolver); and, on the other hand, we learn that the Confederates have introduced a self-feeding rifle, the cartridges (containing their own ignition) being first placed in a receptacle hollowed out for them in the stock, and supplied in rapid succession to the barrel by the mere action of full cocking the piece. With such means of destruction, the American war must surely, ere long, bear some analogy to that waged by the Kilkenny Cats.—A.W.

DESCRIPTION OF BREECH-LOADERS ON PLATE XXXI.

WESTLEY RICHARDS'.

Fig. 8 represents cartridge inserted and breech closed.
Fig. 9 shows breech open to receive cartridge.
Fig. 10, appearance of rifle, with breech closed.

TERRY'S.

Fig. 11, side elevation of musket, with breech apparatus.
Fig. 12, breech apparatus, with cartridge inserted in barrel.
Fig. 13, breech apparatus detached, closed up to breech.
Fig. 14, enlarged view of breech apparatus.

GREEN'S.

Fig. 15, side view partly in section, showing breech apparatus.
Fig. 16, piston or bolt, and the cover of the breech chamber.
Fig. 17, transverse section of the cover of the breech chamber and piston, or bolt.
Fig. 18, end view of ditto.
Fig. 19, breech-plug loose in breech plate, which partly turns round in plate.
Fig. 20, side view, with breech closed, and ready for capping.

MONT-STORM'S.

Fig. 21, side elevation of Enfield rifle fitted with Mont-Storm's breech-loading chamber.
Fig. 22, breech raised, showing cartridge in chamber.
Fig. 23, side view, partly in section, showing position of breech at the moment of firing.

LIEUT.-COLONEL DAVIDSON'S PATENT TELESCOPIC RIFLE SIGHT.*

THE telescopic sight for military and long range rifles patented by me may be described as follows:—

The telescope is contained in a strong steel tube, and is attached to the side of the rifle, so as to meet the eye in presenting; and is capable of being depressed to any required angle, according to the range.

A reference to the diagrams Figures 1 to 8 (Plate XXXII), which are on the scale of one-half, will explain how it is attached to the rifle, with its eye-piece pulled out to focus, and the telescope set for two degrees of elevation.

A and B are collars firmly fitted to the telescope, A at the object end, and B a few inches from the eye end. The front collar A is furnished with an arc C, divided from zero to 12 degrees of elevation. The exact shape of this collar will be seen from the other three views

* A paper contributed by Lieutenant-Colonel D. Davidson, 1st City Edinburgh Rifle Vols., and late H. M. Bombay Army.—ED.

Fig. 1.

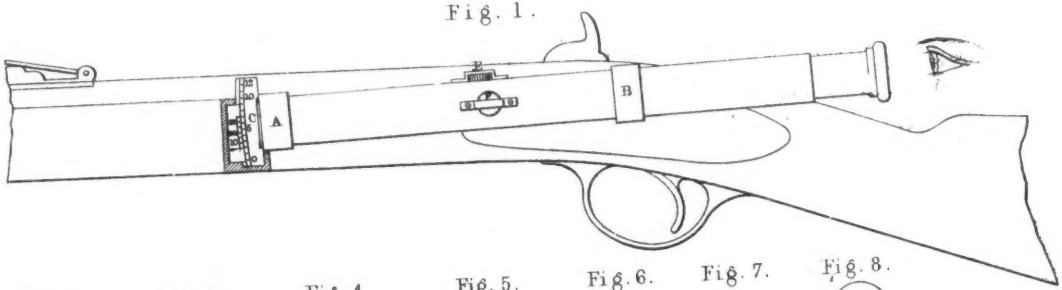


Fig. 2.

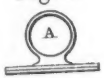


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

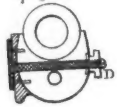


Fig. 9.

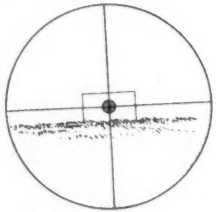
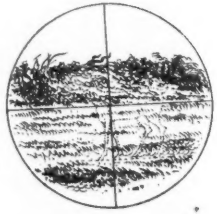


Fig. 10.



J.R.Jobbins.

of it given in Figures 2, 3, and 4. The upper step of the arc is of white metal, and carries the scale.

Figures 5 and 6 give two views of the back collar, B, which has a rounded neck furnished with two feathers or projections. This neck forms the pivot on which the telescope turns. When the telescope is applied to the rifle at right angles to the barrel, the neck enters a hole (see Figure 7) in a plate substituted for the escutcheon plate of the hinder lock screw; and on the telescope being twisted down to a position parallel to the barrel, the feathers, or projections, lock into the inner surface of the escutcheon plate, and hold the telescope firm to the piece.

When the telescope is parallel to the barrel, the inner surface of the arc presses on a plate (shaded in Figure 1) let into the stock, and shown in cross section in Figure 8, also shaded with single lines. Through a square hole in this plate a clamping bolt, cross shaded in Figure 8, is passed through the stock under the barrel. The flat T-shaped head of this bolt which carries the vernier, overlaps the lower step of the arc in the manner shown by dots in Figure 3. When in this position the telescope is set to the required angle by means of the scale on the arc and the vernier on the cross head of the bolt, and it is there securely clamped and held to the piece by means of the milled nut D, Figure 8, on the opposite side of the stock.

When the line or arrow, the zero of the vernier, corresponds with the zero of the arc, the axis of the telescope is by construction exactly parallel to the axis of the barrel both in the horizontal and vertical plane—the constant parallel error involved by placing the axis of the telescope a little to one side of the axis of the piece is of no practical moment.

In the focus of the eye-piece of the telescope, cross lines are placed, the intersection of which, as seen in Figure 9, gives the aim, without its being necessary to see any muzzle sight.

The horizontal line can be raised or depressed for minute adjustment in elevation by turning the milled head E, Figure 1, and the vertical line may be moved to either side for correction for side wind, by the other milled head F, Figure 1.

Having described the telescopic sight, I shall add a few remarks on its peculiar advantages.

When we wish to survey some distant object with more than ordinary exactness, we have recourse to the telescope. A sportsman, in searching for deer, finds a telescope almost indispensable. Military riflemen, too, when engaged at long ranges, avail themselves of its aid. Of this we have a striking example in an incident which occurred in the rifle pits before Sebastopol. One soldier was observed lying with his rifle carefully pointed at a distant embrasure, and with his finger on the trigger ready to pull, while by his side lay another with a telescope directed at the same object. He, with the telescope, was anxiously watching the moment when a gunner should show himself, in order that he might give the signal to the other to fire.

Now it is an established fact to which I can speak from thirty years' practical experience, that by a simple mechanical arrangement such

as has been described, the same telescope which is so useful in searching out the object, can be turned to the best account in taking aim.

Though the present application, which renders the telescope available for the longest ranges, is new, the principle is no new thing, but has long been tested both in India and America. I cannot say how long the telescope has been used as a sight for rifles in America, but thirty years ago, which I rather think was anterior to its use in the New World, I introduced it into India, and used it, along with many other sportsmen, to whose rifles I applied it, with singular success against the antelope on the plains of the Deccan. It not only gives increased precision at long ranges, but it enables the sportsman to aim at deer and bustard, which, from the intervening grass and bushes, could not be sighted with the naked eye. More than once I have shot deer with considerable certainty, when I could see only the tips of their horns. On the first occasion of this kind, a gradual rise in the intervening ground hid the deer from my view; but catching the points of his horns in the field of my telescope, I knew the direction in which he stood, and imagining, as with the dotted line in Figure 10, the body of the antelope, I laid the intersection of my cross lines on the region of the heart and pulled. Immediately I heard the well-known thud. The bullet rose in its trajectory so as to clear the intermediate height, and dropping again, struck the deer close to the heart, and killed him on the spot.

Bustards, it is well known, when stalked, get behind the nearest bush, and think themselves secure. This was just the position in which, with the telescope rifle, I liked best to find them; for the telescope enabled me to trace the figure of the bird through the thin foliage of the babool bush; and at one place where they abounded, I shot as many as nine in succession under such circumstances as these, when the ordinary sight could not have been used.

I mention these facts to show the thoroughly practical character of the invention. There are gentlemen now at home and in India, who have used the same rifles to which I fitted telescopes, for more than fifteen years without their getting out of order. In this case the telescope, pulled on to dovetails, run into the barrel; but as it could not be depressed, it was suitable only for the comparatively short ranges required in deer-stalking; the patented telescope may be used at two miles.

The great optical difficulty which has to be contended with in any other mode of sighting but the telescopic, is that which arises from the fact that the eye cannot view with distinctness at the same moment two or more objects placed in a line, but at different distances from it. If one of those objects is looked at intently, the others become obscure. Now, in rifle-shooting with any of the ordinary sights, there are three objects to be brought into alignement, namely, the back sight, the fore sight, and the objects aimed at. In the process of aiming, then, the eye is constantly changing its focus, in its effort to bring these objects into line.

In the case of the telescopic sight, this difficulty is entirely obviated, for the simple reason, that the object aimed at, and the cross lines by

which it is to be intersected, which constitutes the aim, are optically at the same distance from the eye; and the one can be laid as easily upon the other, as I can place the point of my pen upon any spot on the paper before me. This, of itself, would be a great advantage, even if the telescope had no magnifying power, but when added to this it gives an enlarged view of the object, its superiority cannot be disputed.

This seems the proper place to notice what is perhaps the most important practical advantage possessed by the telescope over any other rifle sight in use. With all other sights, and with none more than with the aperture sight, it is requisite to have, what is never had in service, namely, a white target, and a clearly defined bull's-eye; with the telescope this is altogether unnecessary, for the aim can be taken as readily at a small stone or bush on the hill side, as at the blackest bull's-eye on the cleanest target.

A glance at any of the complicated long range sights in use will satisfy any one that they are utterly unfit for military purposes. Besides the difficulty just referred to of aiming with them at any of the objects usually met with in the field, they are from their construction peculiarly liable to injury. Standing up, as they do, above the barrel or the stock, they are much exposed, and their light frame and delicate hinges could not resist rough usage. On the contrary, the patented telescope lies close to the rifle, and is strong in its construction. It does not interfere with the use of the common military sight for close quarters, and it can be taken off or applied in a moment.

There is another practical advantage which must not be overlooked. In aiming at long ranges with any of the ordinary sights, it is necessary to raise the eye to an inconvenient height, and to support the cheek by an elevating check-piece; whereas with the telescope now described, 10 or 12 degrees of elevation may be given, without involving any sensible movement of the eye.

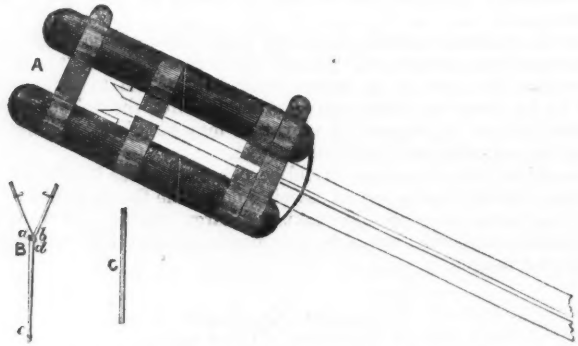
Rifles fitted with telescopes would be of great value in rifle-pits, in dislodging bushfighters, and in keeping down the fire of artillery. A heavy large-bore telescope-rifle, taking a large charge and throwing an exploding projectile, would be serviceable against field batteries at the longest ranges.

NEW LEADER FOR COUPLED ROCKETS.

Contributed by Lieutenant W. F. A. Harris, R.N., Coastguard, Grey-stones, Ireland.

The leaders now in use are very objectionable for several reasons; firstly, from the time wasted in fitting them to the rockets, as will be seen by reading the instructions for their use. "Take a leader and

"insert one of its legs into the mouth of the lower rocket, hook the "hook into the hole in the mouth of the case, and pinch the hook close "between the finger and thumb, take the other leg and insert it into "the mouth of the upper rocket, hook it into its place and close the "hook as before, lay the rockets into the frame, taking care not to "jamb the leader between the bottom of the rocket and the end of the "shaft of the frame inside, pass the loose end of the leader down "through the hole in the lock case, and insert the small end of the "percussion tube into the vent hole (for steadiness only) and close "the jaw upon the seizing where the paper joins the quill." I need hardly remark that, on a dark and cold night, and men likely to be excited at a wreck, there would be a great loss of time, perhaps under circumstances, where every minute would make a great difference in saving life. There also is no certainty in their firing the rockets, when you *have* got them in their places. My experience of them is, that the average, firing the rockets *simultaneously*, does not amount to more than one in four, the leader being generally blown off (without communicating the fire) at the parts marked a, b, c, d; then supposing one leg, say b, to be blown off, and the fire communicated to the one rocket only, by the other leg a, the one rocket has to do the duty of two, and consequently, with its double weight, falls into the water at a distance of about 20 yards. If it is blown off at c, the whole operation of hooking, &c., has to be gone through again with a new leader.



A. Coupled rockets, with leader entered ready for firing.
B. Leader now in use for firing coupled rockets.
C. Improved leader.

Having stated my objections to these leaders, I will proceed to state how my own act, so as to do away with loss of time, and to ensure the simultaneous firing of the rockets, without which a single rocket is much preferable to the coupled. My leader (C) is perfectly straight, and can be entered in a moment, even with one hand, the black end in the lower rocket, the other in the upper; it is then fired as a single

rocket. The fire from the tube ignites the lower rocket, and the leader instantaneously conveys it to the upper, thus insuring their going off together, and attaining the greatest range that can be got out of them; the figure A shows the leader entered and ready for immediate use. I enclose a copy of an extract of a letter from Captain de Courcy to the Commodore Controller-General on the subject, in which he says, "I have to report I witnessed a trial of them on the "3rd, when the line was thrown over the 'Stag' cutter. The leaders "supplied with the rockets often fail in conducting the fire, and are "liable to break at the joint. Lieut. Harris's leaders are easily made, "and much easier adjusted to the rockets than those supplied." This letter was dated March 7th, 1864. On March 14th the matter was forwarded to the Board of Trade, in whose hands it now is.

CALCULATION OF RANGE FOR THE SERVICE OF ARTILLERY.

A Paper contributed by Captain J. R. Campbell, Hants Artillery Militia.

That the course of a projectile is not a straight line, but a curve technically called its *trajectory*, is a fact known to every gunner and rifleman of the present day; and he learns from this that, in order to hit an object, he must give his gun a certain elevation depending on the distance he is from it, the nature of the gun and projectile, charge of powder, &c. Give him the distance or range, and he can, by the aid of certain rules or by reference to tables, ascertain the elevation required. In target practice, where the ground is measured out, this naturally ceases to be a matter of question; but in war, when firing at an actual enemy, or at his works, or ships, the range is seldom or never known. For short distances, and within certain limits of error, it may be *judged* by the eye, but for the higher artillery ranges, especially across water, this is impossible. Artillerymen generally depend upon their first shot or two—*trial shots* as they are termed—correcting each succeeding one by the result of the last, until they strike the object. But there are disadvantages attending this system, which is, besides, clumsy and unscientific. I will mention what I believe to be two.

1stly. In many cases, owing to the nature of the ground where the shots pitch, or other causes, it may be extremely difficult to observe the graze of the trial shots. We read of actions where at least the majority of the shots fired by one contending party have either all dropped short of, or all passed over, the heads of their adversary, and I ascribe this principally to the want of some better method of determining the range. The late engagement between the "Kersage"

and "Alabama" affords no bad illustration of the defects of the present system. Few of the "Alabama's" shots seem to have struck her adversary.

2ndly. During the time you are testing the elevation by trial shots, your enemy, supposing him to have found the range, may be destroying you with shot and shell.

I might, perhaps, also mention the expense of ammunition thus fired in vain, which, in the case of the colossal ordnance now fabricated, can be no trifle. It is said that one projectile from Sir W. Armstrong's 600-pounder would render a ship *hors de combat;* but to do this it must *hit* her, and, I presume, ought to strike close to her water-line; and although I grant that at very close quarters any calculation of the range would be unnecessary, yet cases might occur where our enemy, drawing less water, or steaming faster than ourselves, might be able to avoid this condition.

Now by means of trigonometry we have in most cases the power of measuring the range with sufficient accuracy for practical purposes. There are several ways of doing this; and the object of the present paper is to describe that which appears to me the simplest and most expeditious.

Suppose the distance A X (in the accompanying fig.) to be the range required. A base line A B = 100 units is measured from A at right angles to it. This (on land) may be done by pacing, or better by means of a chain or cord, the direction being taken by a pocket sextant set at 90°. A man or flag is placed at each of the points A, B, and the angle A B X measured by the instrument. Then we have

$$A\,X = 100 \tan. A\,B\,X$$

$$\text{or } \log. A\,X = 2 + \log. \tan. A\,B\,X,$$

from which equation the distance A X may be calculated.

The following table is constructed for the purpose of showing at once the range subtended by an angle read off on the sextant, thereby avoiding such loss of time and trouble as would be required in working out the equation.

The 2nd column gives the ranges or values of A X expressed in units, corresponding to the values of the angle A B X placed opposite to them in the 1st column. The shorter ranges are computed for each successive 10′ in a degree, and the longer ones are taken at every 3′. The 3rd column contains the *mean* value of a minute for angles whose magnitude may lie between that opposite which it stands and the one below it on the table. I have adopted this arrangement in order to render the table concise and handy. It would be easy to construct one with the range expressed for every minute in a degree. I believe, however, the time required in finding the range of the intermediate angles will never exceed a few seconds.

TABLE.

Angle.	Range.	1′=	Angle.	Range.	1′=	Angle.	Range.	1′=	Angle.	Range.	1′=
78° 41′	500	·7	83° 15′	845	2·2	85° 40′	1,320	5·0	87° 15′	2,082	13·0
50′	506	·8	20′	856		45′	1,345	5·6	18′	2,121	
79° 0′	515		25′	866	2·4	50′	1,373		21′	2,160	13·3
10′	523		30′	878		55′	1,401	5·8	24′	2,202	14·0
20′	531	·9	35′	889		86° 0′	1,430	6·0	27′	2,246	
30′	540		40′	901		3′	1,448	6·3	30′	2,290	15·6
40′	549		45′	913		6′	1,467		33′	2,337	16·3
50′	558		50′	925	2·6	9′	1,486		36′	2,386	17·0
80° 0′	567	1·0	55′	938		12′	1,505	7·0	39′	2,437	17·6
10′	577		84° 0′	951	2·8	15′	1,526		42′	2,490	18·3
20′	587		5′	965		18′	1,547		45′	2,545	19·3
30′	598		10′	979	3·0	21′	1,568		48′	2,603	20·3
40′	609		15′	993		24′	1,589	7·6	51′	2,664	21·0
50′	620	1·2	20′	1,008		27′	1,612		54′	2,727	22·3
81° 0′	632		25′	1,023	3·2	30′	1,635	8·0	57′	2,794	23·3
10′	643	1·3	30′	1,039		33′	1,659		88° 0′	2,864	24·3
20′	656		35′	1,055		36′	1,683	8·3	3′	2,937	26·0
30′	669	1·4	40′	1,071	3·4	39′	1,708	8·6	6′	3,015	27·0
40′	683		45′	1,088	3·6	42′	1,734	9·0	9′	3,096	28·6
50′	697	1·5	50′	1,106		45′	1,761	9·3	12′	3,182	30·3
82° 0′	712		55′	1,124	3·8	48′	1,789		15′	3,273	32·0
10′	727	1·6	85° 0′	1,143	4·0	51′	1,817	9·6	18′	3,369	34·3
20′	743	1·7	5′	1,163		54′	1,846	10·3	21′	3,472	36·0
30′	760		10′	1,182	4·4	57′	1,877		24′	3,580	38·6
40′	777	1·8	15′	1,204		87° 0′	1,908	10·6	27′	3,696	41·0
50′	795	1·9	20′	1,225	4·6	3′	1,940	11·3	30′	3,819	43·6
83° 0′	814	2·0	25′	1,248		6′	1,974	11·6	33′	3,950	47·3
5′	825		30′	1,271	4·8	9′	2,009	12·0	36′	4,092	
10′	835		35′	1,295	5·0	12′	2,045	12·3			

Note.—The decimals in the values of 1′ for the higher ranges need seldom be taken into account, although I have thought it best to shew them.

The following examples will show the working of the table:—

1. Suppose the base to be 100 yards, and the angle 85° 36′, what is the range? For 85° 35′ the table gives 1295 yards, a yard being here the value of a unit, and we see that between the latter range and 1345, the minute corresponds to 5 yards. Hence, 1295 + 5 = 1300 is the range required.

2. Let the base be 50 yards, and the angle observed, 88° 23′. 3472 + 2 × 36 = 3544 would be the distance were the base 100 yards, *i. e.*, if, as in the last example, the unit were 1 yard. In the present case, the unit being half a yard, we must divide the above number by 2, and we get 1772 yards as the range required.

3. Let 200 yards be measured for a base, and suppose the angle = 88° 7′. The value for this angle given in the table is 3015 + 27

= 3042, but as the unit in the present case = 2 yards, we must multiply by 2. 2 × 3042 = 6084 yards is the distance sought.

The value of 1′ is a measure of the *error* in the observation arising from the fact of the sextant only reading to 1′. In the 1st example this error is *not greater* than 5 yards; in the 2nd it is at most equal to 18 yards, and in the 3rd does not exceed 54 yards. This error rapidly increases as the angle approaches 90°.

The above examples show how the same table may be made to serve for a base of any length. But for localities where only a shorter distance than 100 yards is available, it would be advisable to compute a table, on the same principle as that on the last page, to a base equal to the number of yards at command.

It can be readily shown, that if in measuring the base an error is made = d units, the error thereby resulting in R, the range, will be

$$\frac{R}{100 - d} \times d \text{ when the base} = 100 + d,$$

$$\text{and } \frac{R}{100 + d} \times d \text{ when the base} = 100 - d.$$

When d is small (say 1 or 2 yards), we may neglect it in the denomination in calculating this error, and consider it $= \frac{R}{100} \times d$ nearly.

Thus, suppose 98 yards measured for 100 in the base, and the real range to be 3000 yards, the observation would give about 60 yards too much, viz. 3060. Should the base be more than the proper length corresponding to the table, say 102 yards, then, the result of the observation would be 60 yards too little, viz. 2940. It appears to me that this method of measuring range might be employed on board ship, although, owing to my want of experience in naval gunnery, my opinion on this point is of little value. Suppose, however, an imaginary base line of 50 yards or more, according to the size of the vessel, to traverse the deck from stem to stern parallel to the keel. A telescope, centered in a vertical plane perpendicular to this base line, is mounted over the end nearest the stern. When the range is to be taken, the ship is brought round, either by her screws or rudder, until the object to be fired at can be seen through the telescope. At this moment the base line will be at right-angles to the range, and a signal from the officer at the telescope to one at the other extremity of this line gives the time for the latter taking the angle (by quadrant or sextant*), which being read off, and referred to a table calculated to the base line of the ship, the range is obtained with more or less accuracy according to circumstances.

Tables of this kind might be rendered more complete by the addi-

* Or this may be done by means of a telescope, mounted in a similar manner to that at the stern (both being furnished with cross wires), the former having, however, in addition to its motion in a vertical plane, one also round an upright axis, like a theodolite; its position with regard to the base line being indicated by the degrees and minutes on an arc in a plane parallel to the deck.

tion of extra columns showing the elevations for the guns, and length of time fuze due to each range.

Doubtless there are cases on land where the range could not be found in the manner I have described, owing to the impossibility of obtaining a sufficient length of base for all directions of fire. In some such cases other means are practicable. The range from a fort on a hill overlooking the sea, for instance, is easily estimated by the *dip* or angle of depression of a theodolite. This angle read off on the vertical circle of the instrument, and the known height of the telescope above the water, furnish data for the construction of range tables, in using which, however, a correction for the height of tide must be applied, similar in *principle* to that shown (page 434) for an error in measuring the base.

Again, where a fort covers a small island or has its front washed by the sea, a base of 100 yards may generally be obtained, weather, &c., permitting, by sending out a boat attached to a rope of this length,—the observation being taken on shore where the other end of the rope is fixed.

Measuring the vertical angle subtended by a distant object and from it deducing the range is a common plan, but it has several drawbacks, the height of the object is usually only *supposed*, and in the case of a ship she may have a *heel* which will falsify your result, even supposing you to know the exact height of her truck above water. The variation, in the angle too, is so slight compared to that in the range, that no sort of accuracy can be expected in long ranges.

In conclusion I would suggest the applicability of the table (page 433) for other purposes than those of gunnery, such as measuring the breadth of rivers, and in taking rough military surveys.

PROPOSAL FOR THE ESTABLISHMENT OF SANITARY OFFICERS IN POPULOUS DISTRICTS, WITH THE VIEW OF IMPROVING THE STANDARD OF PUBLIC HEALTH, AND AMELIORATING THE CONDITION OF THE ARMY MEDICAL DEPARTMENT.

Contributed by R. Domenichetti, Esq., M.D., Surgeon, 75th Regt.

In the present day no fact has been so generally recognised as the improvement of the public health by attention to the principles of sanitary reform, whether we regard the condition of the Army and Navy, or the civil population of this country. It is not my intention to consider how this has been brought about, but merely to advert to it as an accomplished fact, the details of which may be seen in the elaborate statistical reports of the Registrar-General.

With the view of enforcing these principles, and applying them

more closely to the requirements of the country, I venture to offer these suggestions, because it is apparent that they have hitherto been only partially carried out in large communities, and as yet the rural districts of the kingdom, where a high standard of health should prevail, are now frequently the scene of much suffering and mortality, through the prevalence of fevers, &c., which have been aptly classed amongst the preventible diseases. It is well known that these evils have arisen through want of sanitary precautions, from the absence of any organization to enforce cleanliness; and from want of attention to drainage, &c. It is obvious that medical men who derive their incomes from the population by which they are surrounded, naturally feel reluctance in bringing to the notice of the authorities what they may deem obnoxious to the public health, because such a course would bring obloquy upon them, and injure their professional interests. It may be urged that there are local authorities invested with powers under the "Public Nuisances Act," whose province it is to suppress these irregularities, but I maintain that it is essential to have the superintendence of these functionaries carried out by well-educated professional men, whose attention has been directed to the subject, and who have made it their study.

With this view I propose to employ half-pay medical officers of the Army and Navy to carry out throughout the empire the principles of sanitary reform, and few would be inclined to cavil at this arrangement, for such a course would relieve the Government at this juncture of a great source of embarrassment, in connection with the medical department of the army more especially.

By granting an optional retirement after 21 years' service to medical officers on a liberal scale, and appointing them to posts in the sanitary commission, an additional source of income would thus be opened to them in the shape of an allowance for house rent and travelling expenses; and the medical service, now so depressed by slow promotion, would be resuscitated, so to speak, without any great drain upon the Imperial Exchequer, for numbers of medical officers would gladly accept these appointments when entitled to them through length of service, for the sake of the advantages which they would offer as permanent posts.

I could dilate at length upon the utility of this scheme in at once diminishing the death rate of the districts where this system was enforced, for thousands of instances might be adduced where attention to sanitary precautions might have saved the lives of many members of a family whose deaths have been owing to some glaring violation of sanitary principles. This must be conceded by all who have paid any attention to the subject, and we have proofs that the system, as now carried out in the army both at home and abroad, although attended with some outlay at first, has resulted in the saving of a vast number of lives and money to the state. The country owes a debt of gratitude to the late Lord Herbert and the present Secretary of State for War, Earl de Grey, for their labours, and the influence they have exerted in carrying out these beneficial designs in regard to the army, and I predict that before many years have elapsed, the principles of

sanitary reform will have been applied equally to the civil population of the country. Moreover, the difficulty of obtaining candidates for the medical department of the army arises from the certainty of slow promotion for the junior grades; but by adopting this expedient, a double object would be obtained, without conceding too much to the clamour which has been raised against the authorities for an evil which has arisen from circumstances beyond control. Moreover, I have to urge this more strongly because a belief is entertained that measures are about to be taken by Government for the diminution of a certain class of diseases which have seriously impaired the efficiency of the Army and Navy, and I am sure it will occur to those whose province it is to devise means of reform, what valuable aid may be given by the establishment of a sanitary commission such as I have proposed.

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*PROPOSALS FOR THE FORMATION OF A CORPS OF MARKSMEN FOR IMMEDIATE SERVICE ON THE FRONTIER (INDIA).

By Captain J. C. Cox (late Instructor of Musketry), 1st Battalion, 20th Regiment, Camp Boolundshahr, near Meerut, November 30th, 1863.

Introductory Remarks.

At this season of the year a large number of soldiers, whose period of service (10 years) has expired, annually leave their regiments, principally for the purpose of returning to England, to see their friends, families, &c. For the most part these men are totally regardless of the advantages they lose by leaving this country, viz., 1st—The large bounty which, together with compensation money, &c., amounts to upwards of 140 rupees. 2nd—The loss of five years' service deducted from their first period of service, if they re-enlist within six months after arrival in England. 3rd—The total loss of reckoning their first period of service if they re-enlist after that time, which it is computed that about seven-tenths of them do.

After ten years' service a soldier may be considered to have arrived at a perfect state of proficiency in his profession, and, therefore, it should be a matter of the highest importance to endeavour to induce these men to re-enlist before leaving India.

For this purpose it is deemed advisable that a further inducement should be held out to the men to re-enlist, by introducing a "recruiting system" somewhat similar in its principles to the one in vogue in England, that is, giving a small sum, say, —— rupees in lieu of the

* On account of the value of these proposals for general frontier service, it has been thought desirable to give them publicity in the Journal of the Institution.—Ed.

thirty shillings paid for the bringing of a recruit at home to the man who re-enlists him.

Many good soldiers will not re-engage at the head-quarters of their Corps, for private, and sometimes regimental reasons; and were "recruiting depôts" established on the above principle at the three Presidencies, it is believed that many of them would re-engage in other corps, and that thus an enormous expense would be annually saved to the Indian Government; as the cost of replacing a soldier at the head-quarters of a regiment is estimated to be upwards of 200*l*. This year in particular a great number of smart well-trained soldiers are claiming their discharge, amongst whom is a large proportion of "marksmen;" these men properly equipped and led would be invaluable on the frontier at the present crisis. The formation of a Corps of marksmen thus constituted, would be a saving of a great expense to Government, and would (if such a Corps be required) avoid the necessity of applying to regiments for volunteer marksmen.

Formation of Corps of Marksmen.

It is proposed, should it be deemed advisable, that the Corps should be constituted as follows:—

1 Captain, Commandant.
1 Lieutenant, Second in Command.
1 Lieutenant, Adjutant and Quartermaster.
3 Subaltern Officers doing duty.
1 Medical Officer, and Staff of Apothecaries.
1 Serjeant-Major.
1 Musketry Instructor Serjeant.
1 Quartermaster Serjeant.
1 Orderly Room and Paymaster's Clerk.
1 Armourer Serjeant.
1 Bugle Major.
6 Serjeants.
12 Buglers.
120 Rank and File.

Further, that the whole of the officers shall be in possession of a first-class certificate from the School of Musketry at Hythe, or Fleetwood, in order that they may thoroughly understand the value of the weapons with which it is proposed to arm this Corps, and that every non-commissioned officer and private must have qualified himself as a marksman during the last annual course of musketry instruction, and be in possession of at least one good-conduct badge, and also be in a good state of health, of athletic frame, and capable of undergoing those peculiar hardships to which, from the nature of the duties he will have to perform, he must at times be exposed.

Enlistment.

That the men of the above Corps should be re-enlisted for 10 years' general service, so that in case of any misconduct, the Commandant,

with the sanction of his Excellency the Commander-in-Chief, may have the power of removing any man to his former, or any other Corps serving in the country. It is to be hoped that the above stipulation will be of much use in making the men steady and trustworthy.

Pay and Allowances.

In order that the best men may be induced to enter the Corps, it is proposed that an allowance be granted, in addition to the pay at present given to infantry regiments, on the following scale per diem each:—

	Rupees.
1 Serjeant Major 1 Musketry Instructor Serjeant 1 Quartermaster Serjeant	2 0
1 Orderly Room and Paymaster's Clerk 1 Armourer Serjeant 1 Bugle Major	1 8
6 Serjeants	1 0
6 Corporals	0 12
12 Buglers	0 8
114 privates	0 8

The staff pay of officers to be left as a matter for future consideration.

Dress.

As the great object of a marksman is to be as invisible to his enemy as possible, and as it has been proved, by experience, that a light drab colour is best suited for this purpose, it is recommended that this colour be adopted, and that the whole of the equipments and clothing be assimilated in shade as much as possible.

Coat—a loose tunic of thick pushmeena or puttoo.

Breeches—of corduroy, with continuations of cloth.

Gaiters—from the knee, of leather or canvas, fastened by running loops.

Caps—for full dress in hot climates a turban; for undress and in temperate climates a forage cap, without peak, surrounded with a band of mohair lace, with cross rifles and crown in front.

Boots—laced up in front; or, for the hills, sandals.

Great Coat—of the same material as tunic, warmly lined, to be worn rolled over the right shoulder, and rifle case; the ends to be strapped together under the left elbow.

Moreover that each man be provided with three warm flannel shirts, in addition to the kit with which he is already provided.

That the officers' dress be precisely the same as that of the men, with the exception of the usual stars and crown on the collars, which are to be of a drab material.

Equipments.

Rifle.—Rifled on Lancaster's principle, with improved twist, bore 557, length of barrel 2 feet 9 inches, breech-loading, sights attached

for 1,000 yards; also telescopic sight, with lens for use at night; to have a sling of drab colour, and to be fitted with ramrod and self-capping apparatus. N. B.—As this rifle will be exactly of the same bore as those at present in use in the army (should the breech-loading ammunition run short), it can be used as a muzzle-loader with the ordinary ammunition, and as it will take some time to procure the rifles from England, the Corps may, in the meantime, be equipped with the ordinary Enfield rifle.

Bayonet.—Sword pattern, as used in rifle regiments.

Belts, &c.—The rifle, with cleaning apparatus, &c., be enclosed in a leather case, and to be fastened on the back, muzzle upwards, by a belt passing over the left shoulder and under the right elbow, and buckled in front. The bayonet to be fastened round the waist by a similar belt: the fastening of this belt to be a snake buckle.

A Ball Bag for loose ammunition, capable of holding twenty rounds, to be worn on the right side, attached to bayonet belt by straps, and pouch capable of containing forty rounds, and attached to bayonet belt by sliding straps, to be worn on the left side, in front or at the back, at the option of the wearer. A bag for caps, with which to supply self-capping apparatus, to be fixed on the cross-belt for supporting rifle, a little below the buckle.

Officers' Equipments.—Sword, sling-belt, with leather scabbard, a ball bag to be carried on the sword-belt in front, on the left side. On the right side, in front, fastened to the sword-belt, a pair of powerful binoculars in case.

A revolving rifle, sighted to 500 yards, to be carried on the back in case, as by the men, with belt, buckle, cap-pocket, &c.

N.B.—The whole of the pouches and cap-pockets should, if possible, be made perfectly water-tight, and the belts, pouches, rifle-cases, &c., should, as nearly as possible, assimilate to the drab colour of the dress. Should the officers require it, they could carry extra ammunition in a pouch fastened to the sword-belt behind, as the men.

The Corps to be Mounted.

As such a Corps as the above would be exposed to great hardships from forced marches, &c., and as much of their efficiency would depend on the celerity of their movement, it is proposed that each man be mounted on a sure-footed hill-pony, between 13 and 14 hands high. Equipped with an ordinary hunting saddle and bridle, a blanket to be strapped in front of saddle, and a leather case, containing compartments for water-bottle and cooked provisions, behind. It will be observed that in dressing and equipping the "marksmen," care has been taken to make the dress suitable for riding, as well as serviceable on foot, and that both hands have been left free for the management of a horse, if required. The rifle is also so placed as to be least liable to be injured in case the soldier should be thrown, which may be expected frequently to happen on the first formation of the Corps. The syces should be dressed in warm suits of the same colour as the soldiers.

Camp Equipage, Carriage, &c.

As it is necessary that the baggage of this Corps should be as light as possible, no soldier should, on any account, be permitted to carry more than 12 seers' weight of baggage, and an officer only 24 when on service (including cooking utensils, and servant's traps, &c.). Tents to be of the Chodaree pattern, and capable of being carried by two coolies, each to accommodate seven men. In districts where ponies are not available for use, it is proposed that the baggage, ammunition, forage, &c,, be carried on mules, and when in very hilly districts, by coolies.

Further Suggestions.

In order to render this "Picked Corps" still more popular in the army, it is proposed that, during the time of year it is not required on service, it be located in a small settlement for itself, in a salubrious climate, not far from one of the sanataria; that cottages be there erected, capable of containing two, three, or four soldiers, at their own option. That workshops be built, where trades, principally of a fancy character, such as photography, printing, book-binding, fancy painting, gilding, &c., may be carried on. That a large garden and farm be established for the purpose of rearing and fattening an improved breed of cattle, pigs, and poultry of all sorts, and of supplying vegetables, fresh eggs, and butter. The produce of such workshops and of such a farm and garden would find a ready market in such a sanatarium as Simla. In order to improve, in an educational point, the position of the men, it is proposed that a schoolmaster be appointed to the Corps, who is capable of imparting instruction in mathematics, history, geography, drawing, &c., &c. It is considered advisable that this schoolmaster should have passed in Hindostanee, as it is a well-known fact that one European can attain a proficiency in the language from another more easily than from a native, especially if the learner be a man of poor educational attainments. Such a schoolmaster would, moreover, be qualified to act as interpreter, and even as paymaster to the Corps, should his services be required. A staff salary of 150 rs. is recommended to be given for this purpose. In order, as much as possible, to improve the moral and physical condition of the men, it would be advisable to encourage *marriage* amongst them, in a much greater proportion than that now allowed to other regiments, and that every facility be afforded to the married men of making themselves and families comfortable in the proposed settlement; but at the same time care must be taken to impress on their minds that marriage must be no impediment to the fulfilment of those active duties they may be called upon to perform at a moment's notice. As regards the workshops, farm, and garden, &c., it is proposed that at the end of every month the profits of each trade, &c., be ascertained for the current month, and that, in proportion to the profits, the men who work, be paid liberally for each hour's labour; but that it be distinctly understood that money accruing from the extra pay of the Corps, or

from such labour, be not allowed to be used for the purpose of purchasing the men's discharges, but that a savings' fund be established, in which the men may lay by their money, and that when a soldier has laid by a sufficient sum, he may be allowed to invest this sum in any scheme he may think proper, such as railway shares, tea plantations, &c., or that he may invest it in his own name in one of the Indian banks, for which, as a permanent deposit, he will receive the usual percentage as interest.

Concluding Remarks.

Although the equipments will be rather an expensive outlay, it is considered that such outlay will be soon covered, by the saving to Government the cost of replacing the discharged men by recruits in their regiments, and also by having immediately at hand a picked body of men, combining the advantages of efficient riflemen with the celerity of the cavalry soldier. Could this Corps be brought to the state of efficiency of which it is capable, no troops in the world, of equal numbers, could stand against them. They would possess the precision of the Voltigeur with the ubiquity of the Cossack. Should a sufficient number of marksmen not be attainable from the time-expired men, it is proposed that two or three volunteers be procured from each regiment in the Presidency, in order to complete the required number.

Should this scheme turn out a successful one, it would perhaps be advisable to increase the number of the Corps; but this matter is left as a subject for further consideration.

It is further suggested that the soldiers of this Corps, on being discharged at the expiration of their service, shall either be permitted to retain their cottages in the settlement, or, if they prefer it, a small grant of land may be given to them in any other part of the Presidency, on condition that they settle on it personally, and are liable for military service, if called on, and be paid for performing the same. By this simple expedient a certain number of military settlers may be obtained.

Monday, May 16th, 1864.

Captain LEOPOLD G. HEATH, R.N., C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 2nd and 16th of May, 1864.

LIFE.

TAYLOR, C. S. S., Lieut., Royal Horse Artillery, £9.

ANNUAL.

Plummer, H., Capt., 7th Royal Fus., 1*l.*
Barker, J. B., Capt., 75th Regiment, 1*l.*
Paley, R. S., Capt., 12th Royal Lancers.
Le Quesne, J. C., Capt., 12th Royal Lancers.
Gower, E., Capt., 12th Royal Lancers.
Cox, A. C. W., Cornet, 12th Royal Lancers.
Spragge, F. P., Lieut., R.E., Bengal, 1*l.*
Evelyn, C. F., Capt., 3rd Royal Surrey Militia, 1*l.*
Dakyn, J. H., Surg., late St. Kit's Militia, 1*l.*
Hall, W. King, Capt., R.N., 1*l.*
Sim, C. E., Capt., R.E., 1*l.*
Pilleau, H. G., Lieut., R.E., 1*l.*
Blood, B., Lieut., R.E., 1*l.*
Chichester, H. A., Capt., 81st Regt., 1*l.*
Miller, T. C., Ensign, 59th Regt., 1*l.*
Burke, H. P., Capt., 91st Highldrs., 1*l.*
Daubeny, W. A., Lieut., 3rd Buffs, 1*l.*

PROGRESS OF ORDNANCE ABROAD COMPARED WITH THAT AT HOME.

By Commander R. A. E. Scott, R.N.

In my lectures in April and May, 1861,* I gave an account of the various systems of rifling in this country, and showed the advantages and defects of the plans of Mr. Lancaster and Mr. Haddan for firing iron shot, and of Mr. Jeffrey's and Mr. Britten for firing lead-coated projectiles.

I showed that neither of the two former were well adapted to round ball firing, Mr. Lancaster's rifling giving the round shot an increasing spiral motion instead of spinning it round its axis, and Mr. Haddan's rifling cutting away too much of the surface of the bore.

I also pointed out that the elongated projectiles of both these rifled guns pressed outwards against the bore with a violent thrust, which, in shell firing, especially from the Lancaster gun, was liable to cause

* See Journal, Vol. V, p. 423, et seq.—Ed.

the fracture of the shells, as happened in the competition trials of 1861; but I omitted to point out, that Mr. Haddan's larger projectiles were proposed to be made with two bearings, put on in line with their long axis, (Plate XXXIII. fig. 1):—*Mr. Haddan was, I believe, the first to fire a large cannon projectile, tapered at the rear (Fig. 2), but Mr. Woolcombe, of Plymouth, was the first to show clearly the advantage in range attainable by this form.

Of the lead-coating plans I showed that, from the lead being driven out at the base of the shot, the shot's point, having no support to keep it up in the centre of the bore, it must of necessity drop; also that lead would not withstand the large charges of powder necessary to pierce armour plates, and that such shot were extremely liable to accidental injury, in carriage, handling, and storage on board ship.

With reference to the coil guns, as then constructed, I pointed out their liability to open, from the numerous small pieces of which they were constructed, and from these not being hooked together; and of the liability of their inner tubes, to show flaws; and I predicted the failure of such delicate weapons in actual warfare. After adverting to the evils arising from the use of lead-coated shot, and showing the great strain thrown upon the gun in the compression system, to the danger of the breech apparatus, the serious fact that the breech-loader, from this weakness, was as unsuited for chase as for broadside guns, was pointed out: in short, I endeavoured to make it clear, that the requisites for good naval guns were not complied with, either in the systems proposed for adoption by the inventors I have named, or in those guns actually adopted into the service.

In my lecture this evening, I propose going through the modifications since then introduced into our own, as well as into foreign artillery; and I trust I shall be excused if here and there I appear too anxious, in the comparisons I shall have to institute, to show that, in what I foresaw and foretold, I have been correct. Unless I had been correct in some of my conclusions as to results, I should have little excuse for again trespassing on your time and attention. And I further hope, in my concluding remarks, to touch upon some of the points in connection with the vessels which are to carry and withstand the ordnance I shall have to describe.

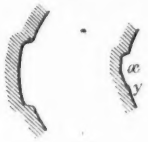
There is nothing like ventilating these questions in a country so full of inventive genius and mechanical ability as our own, and I believe it is owing to the course pursued by the Iron Plate Committee, presided over by that accomplished sailor, Sir John Hay, and numbering amongst its members Dr. Percy, of European celebrity, as well as Mr. Fairbairn, that such a vast improvement has been already made in the

* The projectiles used for the Lancaster guns in the Crimea were straight, and about the middle of 1860, the cast-iron shot for the oval rifled cast-iron 32-pounder were still straight, but covered at the rear with a wrought-iron casing, which projecting 4 inches beyond their base gave space for the insertion of wooden wedges. These were intended to force out the casing, which had two slits so as to fill the bore, but the plan was afterwards given up, and about the beginning of 1861, shot were for the first time made which were fitted to the spiral of the oval rifling.—R.A.E.S.

Fig. 1.
Haddan's Proposed Heavy Shot.

Fig. 2.
Haddan's Early Shot,
with tapered rear

Fig. 3. Fig. 4.
French.



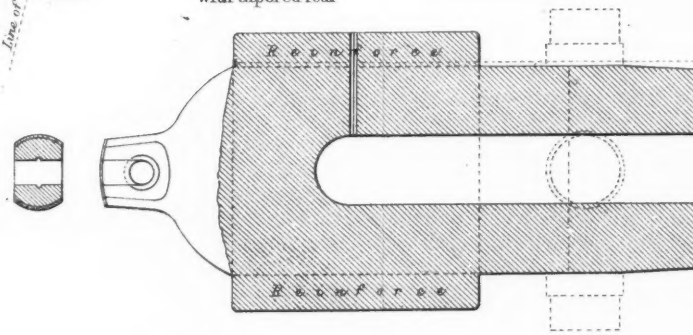


Fig. 9.
15 Inch Navy Gun.

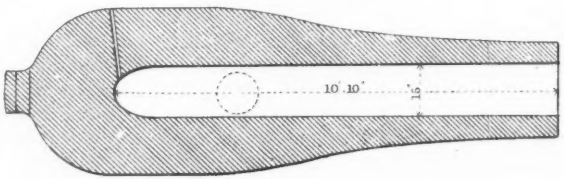


Fig. 11.
Brook Rifling (Atalanta)

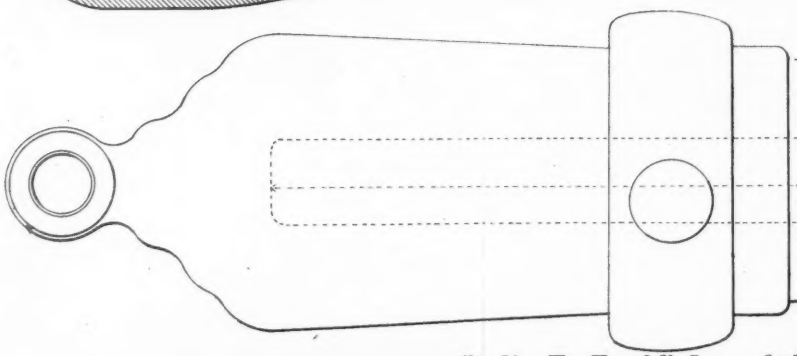


Fig. 12. The Horsfall Gun. Scal

g. 4.

Fig. 5.
French Button Shell.

Fig. 7.
Parrott Rifling.

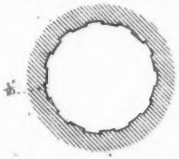


Fig. 8.
Parrott Shell.

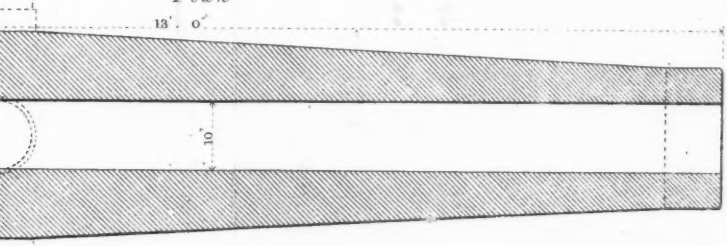
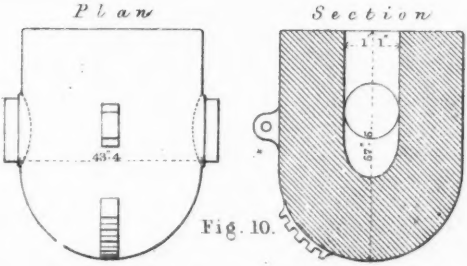


Fig. 6.
Parrott Gun.

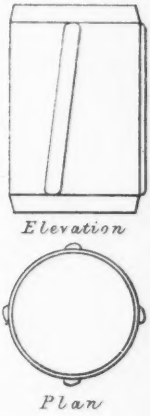
.11.
ng (Atalanta)

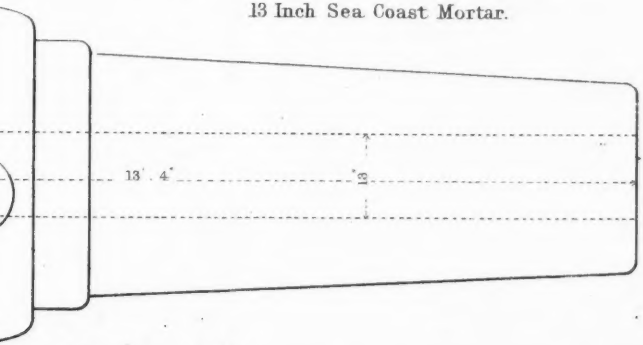
f Gun 7"



13 Inch Sea Coast Mortar.

Fig. 13.
Blakely's Solid Shot.





un. *Scale ½ Inch = 1 Foot*

manufacture of armour plates. Their course has been to freely invite both the target contractors and the ironmasters to come forward, and when at Shoebury, to give them every information; and the result has been, that steady progress which has enabled our manufacturers to produce plates of very superior quality to those made in other countries. I cannot forbear also mentioning the name of Captain Harrison, of the Artillery, the indefatigable secretary, whose courteous behaviour and readiness to impart information has been noticed by all, and I sincerely believe that the valuable hints so readily given by Lieutenant Colonel Henderson, of the Artillery, and by all the committee, have had a considerable influence in the improvement of armour plates. In truth, the whole iron manufacture of the country seems to have received a great impulse from the tidal wave from Shoeburyness. After all, there are few, if any great inventions; it is the constant little improvement in one's own special calling or profession, and the onward progress towards a goal kept steadily in view, that comes at last to be "the great invention."

As that able mechanic, Mr. Anderson, said to me, when I took up with rifled ordnance, in the beginning of 1859, "If you wish to be successful, lay down upon paper all the requirements for a naval gun, consider each point day by day for months, and when you have decided upon what you want, and marked out your course clearly, then submit your plans." Had the course indicated by Mr. Anderson been followed by all, and the same means of knowing results as in the case of the armour plate experiments, been afforded, England's naval ordnance would not have been still in a transition state, but would have been settled upon a firm basis, and the nation would now possess an armament as immeasurably superior to that of other countries, *in proportion to cost*, as are the armour plates now manufactured by her.

It is not, however, too late to retrace the steps which have been taken, and although large sums have been expended through the concealment, hitherto adopted in respect of the coil guns; the different result obtained through the opposite course in plates, *must* for the future, ensure also a more liberal policy in the gun question; this should not be a contest between one powerful company and another, or between individuals for precedence, but a full and open trial of the principles of rival guns, after which there should be selected, without fear or favour, the most practical plan, or the best part of two or more plans, for the national armament. Had the Armstrong mode of construction in the Royal Arsenal been open to the view of the makers of guns, public would have stimulated private manufacture, and *vice versâ*, and England would be at this moment the armoury of the world, as she undoubtedly is the great iron plate maker. True it is, that the energy of our gun makers is fast breaking through all obstacles, but the difficulties interposed have greatly tended to check production, and driven at least one firm to leave the trade. The true policy of England is, to make herself the mart of the world, and by keeping the gun, shot, and armour trade in her own hands, to command the market, and thus have the benefit of production in enlarged trade, and in the superior capabilities and skill in manufacture, which

would be available for the national benefit in all times of need. This policy, alone worthy our great nation, whose favourite motto is, "a fair field and no favour," would in time of peace prevent the squandering of the national treasures, and by keeping us prepared for the time of war, enable Britain to securely maintain her seat as mistress of the seas.

Public opinion, expressed through Parliament and the press, is a great safeguard and a surer defence than dozens of fortresses; but should war overtake us, or another panic occur, a story of the ships (so armed as to be unfit for warfare) might follow "the story of the guns." It has already done so in America. Hear what the New York correspondent of the English "Army and Navy Gazette," (dated 23rd January, 1864,) says, "We are ruled in these matters by a few monied men, who back up the Ericsson interest. No one can deny the fact, that John Ericsson is a splendid engineer, and that there are but few such inventive minds in the United States; but surely that gives him no right to use his utmost endeavours to crush out all who are opposed to him; in certain official quarters his word is law, and the plain truth is, that the Swedish engineer sways a power, in reference to our iron-clad navy, a king might well be proud of. He can purchase opinions; reports can be toned to suit him; faults can, or at least have been, concealed in reference to our ships. Our people have been duped and science thwarted by this man. The reports of the commanders of the iron-clads at Charleston opened the eyes of the public, and queries are more frequent in reference to our ships than ever. It is a sad state of things to contemplate, yet, for all that I can see, we must submit for a time at least. He who favours a Monitor is in favour, but woe to him who reports against them. Look at Drayton, Warden, Rhind, and others, all suffering in a quiet way the displeasure of the department, because they did not say what they did not honestly believe."

French Guns.—In my second lecture, that "on the progress of ordnance abroad compared with that of ordnance at home," given in this theatre on the 20th January, 1862, I pointed out that the principal value of the French cast-iron guns, which had been hooped and rifled, was, that they still fired the round ball—making use of the rifle shells holding a large quantity of powder, but which were projected with a low charge—for the purposes of bombardment; and I showed that the gaining twist adopted by the French, under the impression that the weak cast-iron was relieved by the easy starting of the shot, was a mistake. To-day, I am enabled to say that I have been informed, on what I consider to be good authority, that the French are making steel guns, which they have rifled with an *even* twist upon a simple plan, giving, it is said, a long bearing to their shot. (See Fig. 3.)

Of the performance of their steel ordnance, it is said that 4·3-inch plates, with backing similar to that of the "Warrior," were pierced at 1,000 yards by steel shot from a gun weighing 6 tons.

Prior to the adoption by the French of the centrical grooving, in December, 1862, the French tried a plan (Fig. 4) on a similar principle to that of the shunt, but the buttons upon the projectiles required too

great a nicety of fitting; for, if the shot were large in their diameter, a great strain was thrown upon the gun by outward pressure at x, and if small, then there was a tendency to slip over the shoulder at y. The rifling of the French field-pieces, which are muzzle-loaders, continues to be the same, and the projectiles have similar studs to those that were first adopted by them. (Fig. 5.) This plan, which was used at Solferino and in China, was at the last place very unfavourably contrasted with the Armstrong, but now bids fair to supplant it altogether. (Studs of copper have been lately adopted in England for the projectiles fired from the shunt gun.)*

United States' Guns.—In the same lecture I gave an account of the American ordnance, and have since had opportunities of talking with officers who have taken part in the struggle going on, on the shores and on the rivers of that vast continent. They told me that for ships, their naval men have always been opposed to rifled guns, and though several of the larger Parrott's have been introduced in lieu of heavy smooth bores, it was in opposition to their opinion. One naval officer, who had commanded a squadron, said that their crews were afraid of using the large rifled guns, and that in consequence he gradually got rid of all but a few light chase pieces. Experience gained at Charleston shows that the men's fears were not without foundation, for out of all the Parrott rifles, the great proportion gave way below an average of 300 rounds a-piece.†

A few of these guns went through the re-inforce (Fig. 6), but the greater part gave way in front of it and some guns split near the muzzle, owing to the increasing twist, which, by checking the shell, caused an explosion in the bore, where the shot caught against the rifling.

This was the case in the first 300-pounder at Charleston, which had its muzzle broken after a few rounds. The premature explosion of the shells is about to be attempted to be remedied, by the introduction of a fuse similar in its properties to the fuse of Colonel Boxer.

I should mention that most of these guns were fired at very great elevations which, by preventing recoil, threw a heavy jar upon them at each discharge; they answered well on the practising grounds when fired horizontally, but could not bear the increased strain arising from being fired at high angles of elevation.

The Parrott rifling consists of several rectangular grooves, similar in form to those used by Manton in 1790, and more lately in England by Mr. Britten (Fig. 7); it has an increasing twist towards the

* The French experimented with copper studs, but found that they caused greater wear upon the rifling of their brass field-pieces than those of zinc, which they *adopted*. With the larger shot for their canon rayé of 30, zinc buttons could be readily run upon a rough cast projectile, and were very cheap; the plan was therefore also adopted by the French for the elongated shot of their cast-iron rifled guns.

† Although many of the Parrott guns burst prematurely at Charleston, 1,000 rounds were fired by a Parrott 100-pounder at West Point, and another similar gun has fired 1,400 rounds on service. A 30-pounder also has fired 3,000 rounds into Charleston at from 30° to 40° elevation; and one of the 300-pounders at Charleston has fired 600 rounds. All these guns are still in use, and are in good condition. —R.A.E.S.

muzzle, and the projectiles have a brass ring round their base (Fig. 8), which is expanded out into the grooves by the explosion of the powder. This ring is, however, liable to break without giving rotation to the shot, and it sometimes fails with heavy charges to take the rifling properly. The Parrott guns were at first cast solid and then bored out, but the contractor, who thus made them for cheapness, has now commenced to cast guns hollow, but without trunnions. These are put on afterwards. The early guns were similar in this respect. Parrott and others are now following Rodman's plan of giving no preponderance to the breech of the gun, which is kept in place by the elevating screw. This plan is found to lessen the jar upon the gun, and to preserve the carriage from injury in firing large charges.*

The Americans have now turned their attention to steel, and a firm has recently purchased the right to use the Bessemer process. Actual war, however, is a bad time to make changes in, but the Northern States have so long felt the necessity for a stronger material than cast iron for rifled guns, that they intend to commence the manufacture of mild steel immediately.

The Northern Government very early had an Armstrong gun made by workmen who left Woolwich Arsenal, which gave quite as good results as to accuracy, &c., as the weapons made in England, but on their testing it for continuous firing at high angles, to try its powers for distant bombardment, the breech first got out of order, and then gave way, which caused an abandonment of the plan. It would have been well had they tested their contract Parrott guns in a similar manner.

The 15-inch smooth bore guns, cast hollow, seem to have been a complete success, and to have given velocities of 1,300 feet with 50 lbs. of powder and a hollow shot weighing 420 lbs. (Fig. 9.) The Army gun weighs 22½ tons, and the Navy 19 tons, the usual charge for the latter being 35 lbs., and for the former 50 lbs. The American opinion still is, that to damage an armour-clad or other vessel seriously, it is not the clean, small hole-piercing property they need; "it is the smashing effect, the staving in of planking and timber; or if a hole alone is made, that it shall be so large as to defy plugging." So confident are the Americans of the truth of this, that their forts are either armed, or fast being armed, with 22½-ton guns of 15-inch bore, which will fire hollow shot, and also shells having a large capacity for powder or molten iron. Their effect may in some measure be imagined from the fact that the shell fired from our own "Big Will," the 600-pounder of 13·3 inches bore, entirely smashed the floating "Warrior" target, moored 1,000 yards from the shore, at the low velocity of little more than 1,000 feet per second.

Captain Fishbourne has already told you of the new cast-iron 10-inch American gun, of 7¾ tons, throwing a nearly solid shot of 125 lbs., and a shell of 100 lbs., and intended to fire a customary charge of 30 lbs. of powder. This gun has, in addition, a special charge of 43 lbs. for use against iron-clads—a charge which constitutes it the most power-

* The weight of the 10-inch Parrott is between 11 and 12 tons, charge of powder 25 lbs.—R.A.E.S.

ful broadside gun belonging to any foreign nation. The 11-inch Dahlgren guns have been ordered by the Secretary of the Navy to fire a charge of 30 lbs. of powder if engaging an iron-clad; but the usual charge is, 20 lbs. for a solid shot, and 15 lbs. for a shell.

The charge of 30 lbs. was adopted, after considerable trial when it was found that these 11-inch charcoal iron guns were far stronger than anticipated, and that, as an iron-clad would be engaged at close quarters, and the gun then be laid nearly horizontal, it would have a comparatively small strain thrown upon it.

In the Northern States of America great attention has been paid to the subject of gun carriages, and as the improvements have been suggested by those who have to use the guns, the arrangements for working the guns are exceedingly simple, and the carriages strong, and little liable to get out of order. Their naval gun carriages are in advance of those of any other nation, and they are now about to use iron for their construction.

In their mortars the Americans have adopted as the best plan, that of placing the trunnions at the re-inforce (Fig 10), a plan pointed out in this Institution, which has been found to prevent that splitting in halves in consequence of the wrong position of the trunnions which took place at our own bombardment of Sweabourg. It is a curious coincidence that the solid cast English mortars at Sweabourg, and the solid cast but strengthened Parrott rifled guns, which were likewise fired at high elevations at Charleston, showed about equal endurance.

By placing the trunnions at the re-inforce the mortars can be brought to the horizontal position with comparative facility, and hence used as howitzers for horizontal firing. This property so impressed the Secretary of the Northern States' Navy, that a squadron of mortar-boats was sent to the Mississippi, but the mortars were unhandy, and the damage produced was so trifling, from the inaccuracy of their fire, that they were soon landed.

The Confederate Guns.—The South, although unaccustomed to the founding and manufacture of iron, soon started a foundry for ordnance, and have since continued to turn out cast-iron guns in considerable numbers. The size of bore most in favour for their defences is 10 inches, and it was round steel shot from those 10-inch smooth bore guns which did them such good service at Charleston. Large numbers of their steel shot are said to have been made in this country, and were, I imagine, sent out as *cheeses*, during the time of the supposed famine. It was, I imagine, through pure philanthropy and nothing else, that the sides of the Northern Monitors were pierced.

The Southerners have also their pet rifled gun, which, like the Parrott, is of cast-iron, strengthened with a band over the breech, it is called after Captain Brooke (see Fig. 11), but they found from the capture of their vaunted "Atalanta," intended to destroy the Northern gun-boats in *detail* by firing at long range, that they were egregiously deceived in the power of their rifle, and that their smooth bore was their best gun. The rude means of dispelling their confidence was a 420 lb. shot from the "Weehaken's" Rodman

gun, which shook every timber of the "Atalanta," killing and wounding about 20 men, and paralysing the remainder of her crew. The shock must have been terrific, and from a computation made as to its velocity, it has been estimated that the force of the blow was about equal to that delivered on the "Warrior" target by the 282 lb. shot from the Horsfall gun (Fig. 12), which, when fired from a distance of 800 yards, struck with a velocity of 1,282 feet per second.

The Southerners have received a considerable number of field guns from Europe, and some strengthened cast-iron guns of large bore; and I believe shot of form like Fig. 13 were fired at Charleston. It is said that they have had some built-up steel guns sent them lately. Fig. 14 (Plate XXXIV) represents the pattern of two or three guns which were some time since made at Low Moor, of the 65 cwt. 8-inch pattern, but only bored to 7½ inches, which were then strengthened by steel hoops; but very few of us have now any faith in cast-iron as a fit material for rifled guns. Fig. 15 shows the wrought-iron gun made for the Northerners in 1845 by the Mersey Company, to replace the gun which caused such serious loss of life by bursting on board the United States' frigate, "Princeton." It was proved in England with the following charges, which are very heavy for a gun weighing only 7 tons:—

1st charge of powder, 30lbs., with a wad and shot weighing—
2nd to 4th, 3 charges of powder, each of 44lbs., with double wad and shot.
5th to 30th, 26 charges of powder, each of 30lbs., with wad and shot.
Total, 30 charges.

	ft.	in.
Length from breech ring to muzzle	14	0½
Do. from breech to muzzle	13	0
Do. of bore	12	0
Thickness of metal at breech	0	7¾
Do. do. at muzzle	0	3½
Diameter of bore	0	12

The Prussian system, from which our own lead-coating and breech-loading is a delicate off-shoot, consists of a rifling similar to the Parrott and Manton, with the exception that the grooves instead of being equal in width throughout, narrow towards the muzzle, which I omitted to mention in my former lecture. The object of this is to keep squeezing the lead together, and thus hold the shot up, so that its long axis may continue to coincide with the axis of the piece during its passage through the bore, for as the shot moves onward, the lead coating on its bearings necessarily becomes worn down, and hence the projectile would drop to the bottom of the bore did not this narrowing of the grooves towards the muzzle of the gun, by squeezing the lead together laterally, have a tendency to keep up the shot. It is possible that this ingenious arrangement, which certainly has the merit of not overstraining the gun, suggested the contrivance of the muzzle-nips for the English finely-grooved and shunt guns, as well as suggested the French plan (Fig. 4), the principle being similar and like that of our own early Enfields.

The Prussian projectiles are leaded so as to show raised projections

Fig. 14. Blakely's Strengthened Cast Iron G
with Scott's Proje

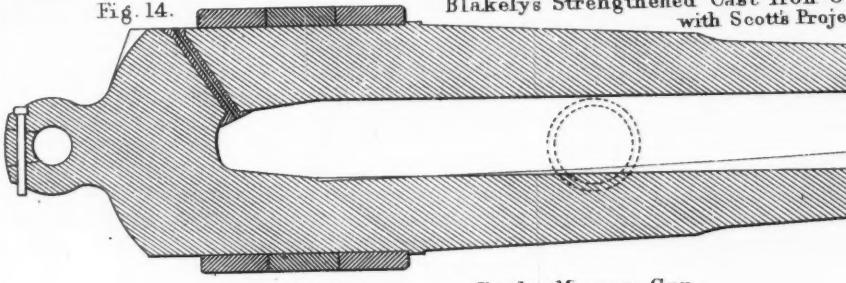
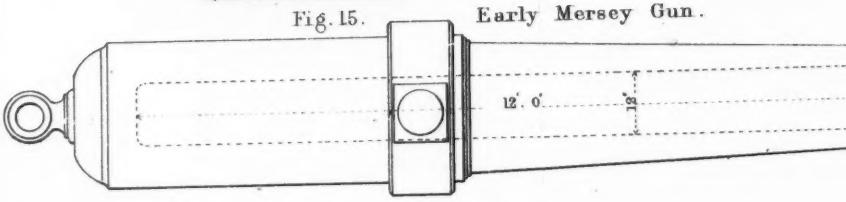


Fig. 15. Early Mersey Gun.



Prussian 24 Pr Gun.

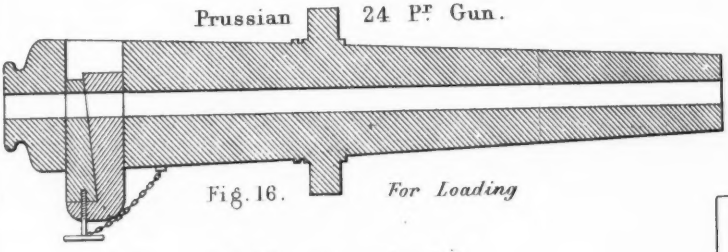


Fig. 16. *For Loading*

Arm

Fig. 17. *Loaded*

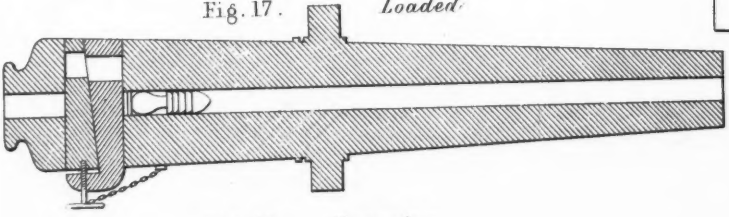
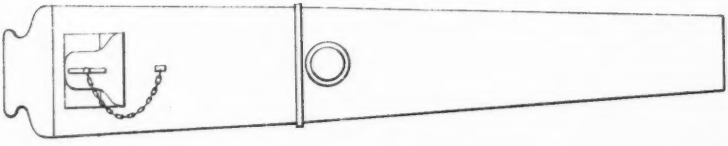
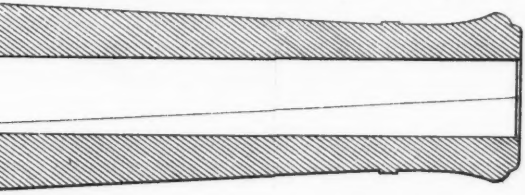


Fig. 18. *Exterior*



Muzzl

ast Iron Gun of 7½ Inches Bore Rifled.
Scott's Projectile.



7½ Gun and Shell.
Transverse Sections.

Longitudinal Section.

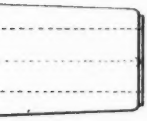


Fig. 19.
Austrian Rifled Gun.

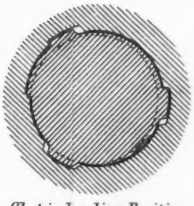


Fig. 20.
Gun-Cotton Gun.

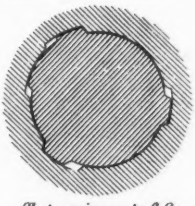
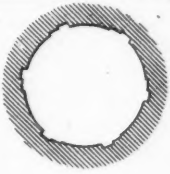


Fig. 21.
Russian Shunt Rifling.



Shot in Loading Position.

Shot coming out of Gun.

Fig. 23.
Plain Groove

Fig. 22
Armstrong 100 Pr. Wedge Gun.

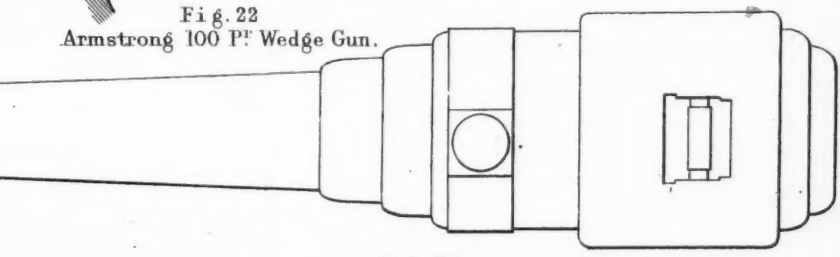
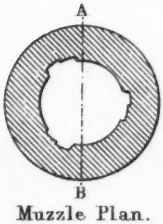
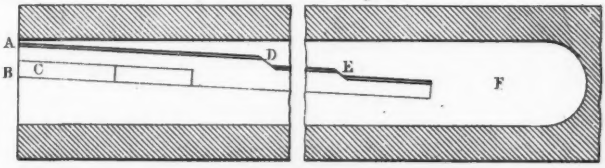


Fig. 24.
Plan of Shunt Groove (Armstrong)
Section through A.B.



Muzzle Plan.



Reference.

A . *Loading Side*
B . *Driving Dº*
C . *Muzzle Grip*
D . *Shunt*
E . *2nd Shunt to lock Shot*
F . *Powder Chamber*

J.R.Jobbins.

of lead (see Vol. V. page 428), which readily squeeze down into the rifling, and hence throw comparatively small strain upon the gun. The Prussian early plan of breech-loading was with one wedge, they then used two wedges (Figs. 16, 17, and 18), but they have not found breech-loading to be so satisfactory as they anticipated, for their guns of the 24-pounder bore and throwing projectiles of 56 lbs. The Prussians commenced the adoption of rifled guns by having field-pieces, made by Krüpp, of mild steel, and the wear of these guns has given them no reason to regret their choice of the metal.* Besides these weapons the Prussians have converted many of their brass guns (remelting several) into rifled breech-loaders, on the wedge plan. The 24-pounder guns of between 50 and 60 cwt., which they were casting and rifling when I read my last paper, are now out of favour, and they are replacing these and their old cast-iron rifles with steel guns. It appears to have been a shot from one of the steel 24-pounders that lately did such damage by piercing the upper deck of the Danish cupola ship "Rolfe Kraake."

The *Austrians*, after numerous experiments with gun-cotton, and *almost* perfecting the use of that manufactured under the direction of General Lenk, seem to be unwilling to incur further expense. They have made little progress since my last notice of their artillery. The rifling of their guns, used for gun-cotton, is shown in Figs. 19 and 20. The peculiarity of this rifling is, that the projectile is given stability to, by tightening itself in a curve of gradually lessening radius, and that the grooves prevent an extreme of wedging action at high velocities; they also give facility of loading.

The position of the *Spanish*, *Swedish*, *Danish*, and *Italian* artillery is much as when I described them in January, 1862.

The Russians have been recently making numerous experiments; they have copied the French button plan, and in some of their solid steel guns have tried a rifling like Fig. 21, and also used a grooving like that in Fig. 3; they have likewise experimented with the rounded form of groove. A very large number of steel shot has been supplied to them from England; and it is understood that most of the 9-inch and 11-inch built-up steel guns, of from 15 to 22½ tons, now making by the Blakeley Company, are for this nation. The Russians have, however, given large orders to Krüpp for *solid* steel guns, and have likewise manufactured several cast steel guns from their own iron, which is of excellent quality, but the large charges and heavy elongated shot used have prevented the heavy solid steel guns, which have been as yet rifled, from withstanding 100 consecutive discharges.† This failure might, I think, be easily cured altogether, but certainly be lessened by the use of lighter shot. But there can be no doubt that the guns are powerful, and will, behind the thick slabs of iron with which their forts are to be covered, prove formidable to

* The French Emperor rejected Krupp's steel from finding, after careful experiment, that guns made of it broke up more readily than French bronze under the blows of the shot which were fired *at* them.—R.A.E.S.

† The reported premature bursting of these guns is said to be in part at least due to the character of the shunt rifling adopted.—R.A.E.S.

any ships venturing to attack them, for they can fire round shot with the heaviest charges.

Having thus briefly noticed the progress of ordnance abroad, it is time to turn to what has been doing at home, and as since September 1861, trials have been made almost exclusively with that principle of making guns and rifling them, concerning which it was declared by one in authority, that the country having adopted the system, was bound to work it out, my account must necessarily be a *résumé* of Sir William Armstrong's plans and inventions.

I have, however, the gratification of being able to state, in respect to some of the mistakes and omissions I pointed out, that although the fine grooving has not been entirely abandoned, no new 110-pounder guns are being thus rifled, and that the Armstrong 12-pounder has been reduced a foot in length, and that by the skill of Lieutenant Reeves, of the artillery, a sort of Dutch case has been adapted to the gun, for use at close quarters.

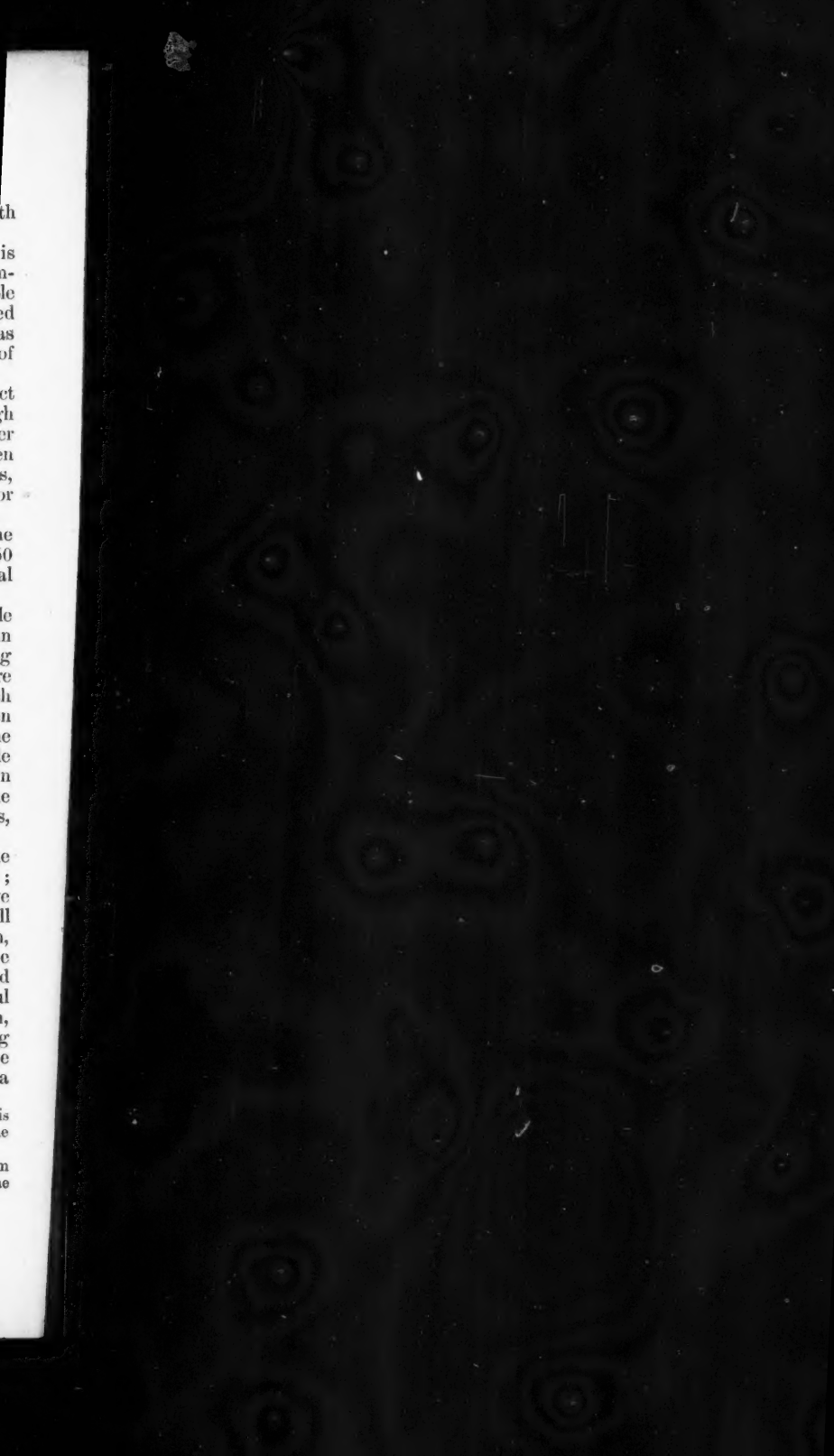
Instead, also, of the new guns being made of excessive length, the 600-pounder is so short, that it approaches the Howitzer, and the 50 Somerset guns building in the Arsenal, are, as to length and general form, all that could be desired for 6-ton naval guns.*

The vent-piece of the Armstrong's is also giving place to double wedges (see Fig. 22), and a vent-hole in the gun, following closely in these changes their Prussian type; in a word, breech-loading having been abandoned by Mr. Whitworth, is flickering in its socket, before being finally given up. The reputation of the shunt system, which was being introduced in 1861, is also on the wane, it having been proved that the early impressions as to the damage that would be done to the muzzle from squeezing the shot were well founded; the whole of the heavy guns rifled on this plan having cracked round or shown flaws at the muzzle, and hence it is in contemplation to give up the shunt and grips, and to come to a plain groove,† with sharp corners, similar to that advocated by Captain Palliser (Fig. 23).

I need not dwell longer upon the failure of the shunt guns, the reasons for which were so clearly pointed out by Captain Fishbourne; but as the same tendency to fracture exists in the sharp cornered groove about to be experimented with, as in the shunt groove, I may call attention to what he says as to the disadvantages of such a form, from its allowing the bearing edges of the projectile to strike the driving sides of the grooves with a force which must wear them, and ultimately cause rupture; the grooves being also liable to foul and difficult to sponge. To reduce the shock upon the shunt gun, the French field-piece button has been adopted by Sir W. Armstrong but instead of white metal, copper, which was at first tried by the French, has been taken, and this has been lately made very soft—a

* They are 9 inches diameter in the bore; the weight of their cast-iron shot is 95 lbs. and shell (which are of 1½ inch thickness) 66 lbs., windage 0·1 inch; the full powder charge is 25 lbs.—R.A.E.S.

† This rifling has been since tried and found to be deficient in accuracy, from having no principle of centring and steadying the shot in its passage through the bore of the gun.—R.A.E.S.



Armstrong's

Fig. 25.
70 Pr Muzzle Loading Shunt Gun.

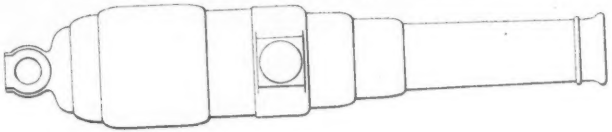


Fig. 26.
12 Pr Shot

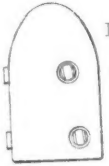
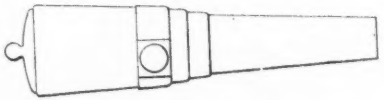
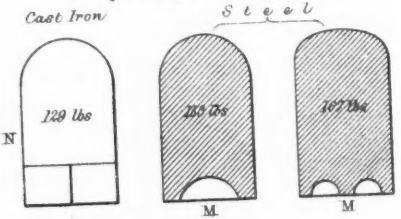


Fig. 27.
12 Pr Shell

Fig. 28.
Mackay Gun.



Projectiles for Mackay Gun.



Base of Shot

Elevation of Target.

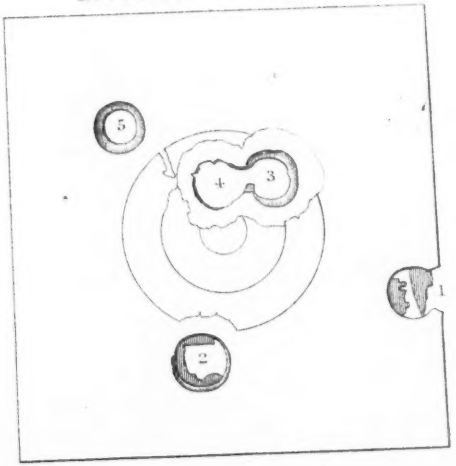
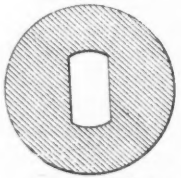
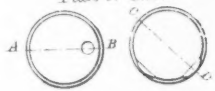


Fig. 29.



Section of Gun.

Plan of Shot.



Section of Shot.

Taken through A B and C D.

J.R Jobbins.

quality which causes the studs to have a tendency to shear, with high charges, and get out of shape in carriage. To further lessen this shock, there is a projection upon the loading side of one of the grooves, which pushes the studs close to their bearing, when, to use the phrase derived, I believe, from Sir W. Armstrong, the shot becomes "locked," and a very tight fit it is (Fig. 24).

The Armstrong and Whitworth Competition.—It was arranged that this trial should be entirely at the public expense, and after various preliminary experiments, Sir William brought into the field three multi-groove breech-loading 12-pounders, firing lead-coated shot, and three muzzle-loading 12-pounders of the shunt pattern, rifled with three grooves and firing shot with copper buttons, the former being supposed to represent the service system, and the latter that system with which it seems to have been proposed to replace it. The Elswick Company also sent three breech-loading 70-pounders, with double wedges substituted for the usual service vent-piece and firing lead-coated shot, and three muzzle-loading 70-pounders, firing projectiles with copper studs. The weight of these latter guns is about 77 cwt., and the breech-loaders, though lighter, are heavier than the three hundred 70-pounders* (Fig. 25, Plate XXXV) made for the service. The projectiles also are different from the service pattern, and so are the shells used with the breech-loading 12-pounders.

All these 70-pounders have steel tubes, and the 12-pounders a solid steel barrel, the rear of the breech-loading 12-pounders is also larger to enable a thicker vent-piece, and a larger screw to be used, which has more threads, for the purpose of holding the vent-piece more firmly than is the case in the service gun. These guns comprise therefore Sir William's latest improvements, but do not represent any guns in the service.

Mr. Whitworth brings to the contest three 12-pounders and three 70-pounders, such as he proposes for the service. He has rounded out the angles of his rifling, and the shot, which are entirely of iron, are also rounded at the corners, a modification which appears to have improved the facility of loading, and to have lessened the wear upon the driving side of the rifling of the gun. Mr. Whitworth's competitive 70-pounders are about 78 cwt., which is a trifle more than the weight of Sir William's competitive 70-pounders.

The contest commenced with one 12-pounder of each pattern—the other 12-pounders being kept in reserve. The weight of these field pieces is:—

Armstrong breech-loader.....	8 cwt. 1 qr. 16 lbs.
„ shunt muzzle-loader....	8 cwt. 3qrs. 27 lbs.
Whitworth muzzle-loader	10 cwt.

The last gun had a vent aperture in the rear, through which it was intended to fire the charge, but there being some objection to the plan, Mr. Whitworth cleverly closed it with a plug, and uses a new vent-hole on the top, which ignites the powder charge at the centre of the cartridge.

* Since called 64-pounders.—R.A.E.S.

In diameter the bore of Mr. Whitworth's gun is smaller, and hence his projectiles have to be longer than those of Sir William's shunt gun, and their length, in order to obtain the requisite weight, has to be further increased owing to the shots being tapered at the rear. The weight of Mr. Whitworth's 12-pounder shot is 11 lbs. 9oz., and that of the shunt shot 11½ lbs. (Fig. 26). In order to contain the same quantity of powder (11 oz.), the Whitworth shell has to be lengthened to four diameters, which is rather beyond what even the sharp rifle twist of Mr. Whitworth's guns can give stability to over 800 yards; hence there is a slight loss of accuracy in firing shells from his gun as compared with those of the shunt, the shells for which are under three diameters in length (Fig. 27), and have a third button in the centre which seems to give them greater accuracy than the shunt shot which have only two.

In firing shrapnel or segment, the one invented by Colonel Boxer, and the other by Mr. Holland, which may be considered as the normal projectiles for the guns, the Whitworth had a slight superiority in range and accuracy. The initial velocity given by the guns was nearly equal, being about 1,350 feet per second, with projectiles brought to the same weight; the advantage was, however, on the side of the shunt, but the retardation of its shot being greater, the velocities were equal at 400 yards, and then the Whitworth took the lead. At 10° of elevation Whitworth's range was about 4,100 yards with shot, and the shunt about 400 yards less, indicating the flatter trajectory given by the Whitworth field-piece. On the commencement of the trial a wet sponge was used for the shunt, subsequently a dry one, but from not using a lubricating wad, the gun had to be well rubbed inside with the sponge. Still it was not loaded with the same facility as Mr. Whitworth's, for it required a tap with the rammer to send the shot home. In the quick firing of 200 rounds, Boxer's lubricator, made for the Whitworth gun, was also used for Sir William Armstrong's shunt, but the time occupied was longer, and the firing was not considered so accurate by outsiders.

The guns have now fired considerably over 1,000 rounds, and are all showing signs of wear; the lands of the shunt rifling being worn on the upper side of the bore, just where the shot lies, from the rush of gas past it, and the rival gun being very slightly rubbed by its own iron projectile; a trifling flaw or fissure also showed itself behind the vent after the 200 rounds of quick firing, but does not appear to have much increased since. It has been thought that the heating of the gun and the consequent intensity of the action of the gases from the powder being ignited at the centre of the charge, may have affected the carbon in the steel, and hence produced this flaw behind the vent. The damage to the shunt, in all probability, had its origin in the want of lubrication, which in Whitworth's gun left a coating which formed a protection against the heavy powder gases that rushed along the bore past the shot, and a rub once being established, the damage would go on increasing.

The advantage of the Whitworth system consists in the projectile being indestructible and capable of being re-fired. The wear upon

the steel bore from the iron shot is very trifling, and, probably, little if at all greater than the wear upon the shunt rifling by the copper studs, which are somewhat liable to injury. The shunt-gun has, however, the advantage of a round bore, and hence is better able to fire any other description of projectile than its own special shot.

I have not hitherto spoken of the breech-loader's performance, for the gun is so far below the standard of the other two, that even some who were the strongest supporters of the system now say, "Let us, at all events, have a muzzle-loader." And in truth they have good reason to say so; for whenever 40 or 50 rounds are fired consecutively, even with moderate quickness, the men in rear of the gun have their faces and clothes blackened by the *mild* escape of gas. It is useless indeed further to conceal the fact, that the soldiers dislike the gun as much as the sailors, and become so nervous in firing rapidly, that during the 200 rounds which were fired quickly about a fortnight since from the gun, the vent-piece was put in the wrong way, which was seen by a bystander, and once the breech-screw was not screwed up, which was also seen in time to prevent accident, by a looker on. The difficulty of working the breech-screw when fouled by the powder gases, and the water which has to be poured over the breech, to stop the heating and expansion of the gun's delicately adjusted parts and allow them to work, have been already publicly noticed. I need therefore scarcely add that the inferiority of this later improved breech-loader to the Whitworth as well as to the shunt, sufficiently justifies what has been said against breech-loading guns, and Mr. Whitworth's complaints of the hasty condemnation of his weapon.

The 70-pounders have not yet been tried, but I have no hesitation in saying that, Mr. Whitworth's projectiles having greater stability communicated by the sharper twist of his rifling will have greater penetration than the Armstrong shot, especially at distant ranges.

The breech-loader will of course be the worst; it is, in fact, 10 or 12 cwt. lighter than the other guns.

The steel shells of Sir W. Armstrong, which have been provided with thin iron caps, will not, I think, produce any very great effect, for the cap which is screwed on in front of these shells will serve as a buffer to break the blow—just as happens with his present hollow-headed shot—a form which has the disadvantage of largely increasing the deflection or drift, and of destroying the evenness of ricochet; serious drawbacks to naval use.

Captain Palliser's Strengthened Cast-iron Guns.—Captain Palliser was furnished with two 68-pounders and one 10-inch gun.* The first 68-pounder was bored out and provided with a single wrought-iron tube of about 2 inches in thickness—so as to leave the finished bore 9 instead of 8 inches in diameter. After enduring 100 rounds with

* Captain Palliser's guns were purposely passed to destruction,—in the usual manner,—to test their strength. One of Messrs. Walker's 68-pounders had previously withstood 76 discharges, which is the largest number of rounds sustained (with a single charge of powder, and iron cylinders increased by the weight of one shot after every 10 rounds) by any cast-iron English gun before being destroyed.—R.A.E.S.

16 lbs. of powder, and increasing cylinders, the gun subsequently burst at the 7th round with double charges of powder and a cylinder weighing 200 lbs.

The 10-inch gun had two tubes, and was finished with a bore of $6\frac{1}{2}$ inches diameter. This gun burst at the 81st round with a powder charge of 16 lbs., and a cylinder weighing 612 lbs. The third gun had a steel tube placed inside one of wrought iron, but the steel quickly split.

The Blakely Guns.—Captain Blakely was the first to strengthen cast-iron guns, and, as Captain Palliser states, to point out the principle of equalizing the strains on concentric tubes. In 1861, two $7\frac{1}{2}$-ton guns and one steel gun were rifled by me for him, and he adopted my principle of centring for iron shot. Captain Blakely also took the same form of grooving for guns firing lead-coated shot, and having, after careful trial, ascertained the greater accuracy obtained from it, he has since rifled all his guns in a similar manner.* Captain Blakely has latterly taken Messrs. Vavasseur's gun premises, and very much extended the works, which are now employed in turning out large built-up steel-guns. These have the peculiarity of being finished with massive cast-iron trunnions;† and I have only to mention that the system used by Captain Blakely is, to fire the round ball, and all the other smooth-bore ammunition, so strongly urged by Captain Fishbourne as essential for naval guns.

Having already explained to you the direction which the alterations in the French, the Whitworth, and the Armstrong guns have now taken, let me specially direct your attention to the groove I have so often and so warmly advocated in this room. You will notice that the French commenced with a gaining twist, that Sir W. Armstrong commenced with an angular groove, which could not fire either the round ball or any of the service ammunition, and Mr. Whitworth with an angular bore and sharp edges to his shot. The French some time since, adopted a groove similar to mine for centring the shot; they have now, it is reported, given up the gaining twist for the *even* twist advocated by me. The Select Committee, who have all these different systems before them, and ought, if any body does, to see the way in which things are tending, are using a groove recommended by Captain Palliser, because, as he believes, the particular angle he selects will centre the shot in the same manner as by my form of grooving which the committee have taken for the gun they intend to fire the leaded-projectiles of Mr. Britten and Mr. Jeffrey from.

I wish now to say a few words on the Armstrong 600-pounder.

This gun, with a charge of 70 lbs. of powder, has been found at 200 yards' distance to just penetrate the "Warrior" backing, covered by a $6\frac{1}{2}$-inch plate; and the striking velocity of its steel bolt of 612 lbs.

* In the rounded form of grooving the iron is not, as it were, "nicked," and has no such tendency to break as in the case of sharp-cornered rifling, which gives a line for fracture. What Captain Blakely says of the rounded grooves fouling less and being much more easily sponged, should not, I think, for the safety of the arms of the men loading the gun, as well as for that of the toes and bodies of those standing behind it, be overlooked.—R.A.E.S.

† Since changed to wrought iron.—R.A.E.S.

was rather over 1,100 ft. per second. With 90 lbs. of powder the same gun gave a steel round ball of 340 lbs. weight, a velocity on striking of over 1,600 ft., the ball hitting near the centre of the small piece of 11-inch plate fired at, indenting it $4\frac{1}{2}$ inches, and owing to its being unsupported in the centre, splitting it in halves. This blow was undeniably by far the hardest yet struck at Shoeburyness, and was effected with much less strain upon the gun than in the case of firing the heavier elongated shot—which were far more difficult to raise for loading and required a very much greater force to send home in the gun. That the strain upon the breech in firing the elongated shot was much more, may be safely inferred, because the weight of the shot to be moved was far greater, and hence the pressure of the gas must be also much greater. A familiar illustration of this is afforded by loading the safety-valve of a boiler with a heavier weight, and then the steam requires to be of greater pressure, before the valve can be lifted; just so in the gun; and there is this further difference, that the elongated projectile has to be fairly pushed out, unthreading itself from the rifling, whereas the round ball rolls over on the first pressure of the elastic fluid, and at once relieves the gun. In cast-iron guns it has been found that after rifling they cannot use half their old charge with the same safety to the gun, as when fired with their full charge as smooth bores.

It is now time to briefly notice the different plans tried in this country to give rotation without rifling the gun.

Hogge's shot, which were amongst the earliest, were scored in front, and although some of them went tolerably straight, the greater part had little stability of flight, and of necessity, a short range. I need not describe them more particularly than to say that from Hogge's early efforts to Sir William Armstrong's late ones, to obtain rotation either by scoring the shot in front so as to be turned round by the air, or to be acted upon in rear by the powder, all attempts to fire with accuracy elongated shot out of unrifled guns have utterly failed.

The disc gun of Mr. Thomas Woolcombe, of Plymouth, is a very ingenious invention. The shot for this gun (Fig. 29) are, as the name of the gun implies, "discs," and are made so as to have their centre of gravity *not* in the centre of the figure. In loading, the heaviest part of the disc is placed on the upper side of the bore of the gun, and is pushed home in this position by a special rammer. On being fired it gives a very flat trajectory up to the first graze; but hitherto the accuracy obtained has been less than that from the ordinary rifled gun, and the shape of the projectile militates against its powder capacity; the penetrating power of the disc is however very great.

The Mackay Gun.

Length, extreme	11	feet	9	inches
Length of bore	10	,,	$1\frac{1}{2}$	,,
Thickness through breech	2	,,	11	,,
,, ,, muzzle	1	,,	$2\frac{1}{4}$	,,
Diameter of bore	0	,,	8·12	,,
Number of grooves	12			

Weight of some steel projectiles.. 153 lbs. .... length 12 inches
and of others ..... 167 „ .... „ 13 „
Charge of powder ..... 30 „
The gun weighs 9 tons, and was forged hollow by the Mersey Company, and afterwards hooped from breech to trunnions.

Initial velocity given by 20 lbs. of powder and projectile of 100 lbs. } 1508 feet
„ by 30 lbs. of powder and projectile of 112 lbs. } 1640 „

The Mackay gun with an elevation of 12°, a powder charge of 25lbs., and a cast-iron shot weighing 129 lbs., gave a range of 3,735 yards. This cast-iron shot was square at the base (see Fig. N). The steel shot fired through the Minotaur target were cupped in the rear (see Fig. M).

Liverpool is the place where these experiments have been carried on, and where the gun was forged by Mr. Clay, who formerly constructed the celebrated Horsfall gun, presented to the nation (Fig. 12), and also made the gun (Fig. 15) which took the place of the piece of ordnance which so disastrously burst on board the American "Princeton." The charges which this gun withstood, viz., 44 lbs. of powder, are very great for a gun so light, especially considering that this was the first attempt at large ordnance made by the Mersey Company, and was the only powerful wrought iron gun made till many years afterwards. It cannot but be a cause of regret that there has been so little inducement given to them to continue the gun manufacture.*

Having thus briefly touched upon the various systems of rifling and the descriptions of guns made in foreign countries and at home, I may show how far the changes made, agree with what has been stated in this Institution, from which it may be fairly inferred that the ventilation of these questions is of great national advantage; and that, had this ventilation been earlier and more thoroughly made, a large portion of the money expended upon weapons, which are of small power and comparatively little value, would have probably been employed in developing the steel manufacture of this country, admitted by Sir W. Armstrong to be still far behind that of the great Prussian firm, represented by Krüpp.

I may remark that other countries have utilized the material already in hand, and expended very little upon new guns; but that England at once embarked in an entirely new manufacture, viz., that of Armstrong guns, and that it was pointed out in the beginning of 1861, at the very outset of this manufacture, that neither the system of construction, the rifling of the gun, nor its lead-coated projectiles, any more than the numerous tools pertaining to the weapon, were adapted for actual service. Later in 1861 the "leading" of the guns, and the delicacy of their whole mechanism began to attract attention;

* The Horsfall gun was fired at Shoeburyness with 74·45 lbs. of powder and a cast iron ball weighing 279 lbs., which got an initial velocity of 1620 feet per second, and gained the first victory over the Warrior target.—R.A.E.S.

and the shunt rifling and muzzle-loading were put forward, and on a war panic, an enormous number of cast-iron shunt-rifled guns were ordered for the navy; happily some of these were burst on the practising-grounds at Shoeburyness, instead of between the decks of our ships; and the war rumour having died away, the order was rescinded. After this the Armstrong guns were alone proceeded with, and their first generally known failure was in the cupola erected on board the "Trusty;" but on the first trial of the larger guns in actual warfare, happily not with foes "yard-arm and yard-arm," but where the ships could move as they liked, the breech-loaders entirely failed, as shown in the report from Kagosima.

A letter which appeared in the "Army and Navy Gazette" of April 30th last, signed by Sir W. Armstrong, inferred that the Admiralty were to blame for this failure through having allowed the old pattern vent-pieces to be used, but it did not state that the vent aperture in the 40-pounders was too small to admit of the new vent-pieces being used, and that there are nearly 300 similar guns out on service. Besides, as the gun is constantly undergoing changes, how is it possible to keep the vessels on foreign stations supplied with the latest improvements.

The construction of the guns has been very much simplified, and in several respects improved since the Arsenal manufacture was left to its proper development, for its chiefs have sought the very best mode of putting guns together, so that even in the limited competition in the Government manufactory of guns, as well as in the free competition in making plates, the country has already derived great benefit. It only now remains to have a "fair field and no favour" in rifling guns, for England to be in possession of what should be the best naval weapon in the world. And I sincerely believe that, were practical naval men appointed, a sufficient sum would be saved in the matter of ships' armaments, &c., to pay the additional cost of a standing navy, and to give the officers that increase of pay which they have been so long and so anxiously looking for.

Lastly, as to plated vessels, I think that erroneous notions of construction are prevalent, from the builders not being thoroughly acquainted with the mode of mounting and working naval guns, and the effects produced by their projectiles, and that hence they have laid too great stress upon the advantages of a thick wooden backing, with a thick armour plate in front of it. Now, Mr. Whitworth has shown us that he can so admirably temper and arrange the metal of his shells, that where he can put a steel shot, he can put a shell also; and it should be remembered that the effect of the explosion of powder always takes the line of least resistance, and hence on a thick plate being penetrated by a shell, moving at a high velocity, and being slightly turned from its direct course so as to close the aperture made, the force of the discharge will act upon the weaker skin of the ship (that is, upon the side proper of the ship), which will in all probability be blown inwards, and the backing set on fire, with a draught through the hole thus made, to keep up the flame. The plate also, in proportion to its thickness, will receive and transmit a greater shock to the

whole structure of the vessel, which, under a continuance of the blows of heavy shot, would be shaken to an extent endangering her safety. The plates, however, would certainly be so much damaged as to require removal, and the sides supporting them would, perhaps, be in nearly as bad a case.

The remedy for this is to put, say, a 6-inch planking of wood over the armour, coating it underneath with Jeffrey's marine glue, and caulking between the planks with the same material.

The wood (compressed pulp or paper would be better) in this position would serve as a buffer, to deaden and reduce the force of the blow: and to support the wood, so as to prevent its opening and spreading laterally, instead of being merely squeezed before the shot, there should be longitudinal stringers of thin iron, crossed by vertical stringers, into which the wood should be firmly packed.

An experiment was tried at Shoeburyness with an inch plate of iron placed in front of wood bolted on over 4½-inch armour, but having no iron stringers to support it: and although the indentations in the thick inner plate were less than half those usually made upon iron plates without this buffer, shells at last blew off the front plate, and destroyed the wood; but this was an experiment made with the advantage of a quiet concentrated fire upon one spot, and therefore very different to what would occur in an action at sea.

But were such an arrangement as that proposed carried out, the sides of vessels of the "Minotaur" class would be impregnable to foreign artillery, and though some of the wood would be doubtless knocked off, still it is not probable that two shots would strike on the same spot.

As to protection from vertical or plunging fire, the vessels of the "Minotaur" class are sufficiently large to admit of an additional inch of thickness of iron upon their decks, for which the necessity was seen in the case of the "Keokuck," at Charleston, sunk by one shot, which went through her deck and bottom; and more lately in the case of the Danish cupola ship so materially injured.

What, then, would be the position of an iron-clad, with a large shell striking upon her deck? The shell would go down through the vessel's bottom, and she would visit Davy Jones's locker, sinking, like the target ship at Portsmouth, which went down from a single 68 lb. shot hitting the underside of the armour plate, and being deflected downwards through her bottom.

We *have* already in our armour-clads a noble class of ships, with ports much higher out of water than the French ships, and sailors who I think it will be admitted are second to none. It only remains, therefore, to have the best guns, and the best means of working them, together with what is still more important, a thorough knowledge of their power, and of the tactics necessary for fighting our iron-clad navy.

I have already shown that excellent weapons are now being turned out from the Woolwich Arsenal, and that the shot, shell, and fuzes made there are very good, but I cannot say that we yet have that desirable means for fighting our guns, or that our knowledge of

tactics for "iron-clads" is not susceptible of improvement. In these we want a thorough ventilation, and perhaps a small naval committee, to encourage improvement, and point out where rewards would be most fitly bestowed, and I have little doubt that the stigma of not having even a good handbook for naval warfare would be soon removed, and with it the danger of going into action without having carefully studied and thoroughly understood what has to be done to bring the fight to a successful termination, and to make it a complete conquest with the least loss of life and damage to our ships (points hitherto too much overlooked). Were this done, England, as skilful in warfare as in iron manufactures and the arts of peace, would still hold her old and undisputed sway as mistress of the seas.

Commander DAWSON, R.N.: I should like to ask a question with reference to the American guns, whether the monster guns spoken of so favourably have any relation to the ones tried against Charleston, of which we read that they burst on the average at the fiftieth round. One is supposed to have reached the seventy-fifth round. I should like to ask if the lecturer is convinced in his own mind that he has good grounds for the statement he has put forth? I do not doubt that he himself is satisfied that he is uttering statements which he has received, but the question is whether he has received them from reliable sources. Again, with reference to the Southern States, I did not hear him describe the shot belonging to the Rodman gun; and as I have had the advantage of hearing a description of the shot from a Confederate officer, it may be interesting to add it to the lecture. The Confederate officer described the process of rotation as being given by a brass sabot, which was fastened to the shot by a spindle. The space between the sabot and spindle was filled up with grease; the sabot itself had a sort of saw edge with a corresponding edge in the rear of the shot. So that on firing the gun, the sabot fitted into the rear of the shot, and being forced out into the grooves, gave rotation; and on the shot escaping from the gun, the sabot fell off. The shot pursued its course without any attachment but the sabot spindle. This I had from the Confederate officer, and I suppose it is correct. With reference to our own guns, I think we ought to take with a certain amount of caution what our friend Captain Scott says about the Armstrong guns. We must remember that Captain Scott is an inventor; he has his own particular hobby, and his own particular class of guns. I should like to ask him with reference to this particular groove that he has put forth, with the rounded edge, whether any guns have been tried with that groove? and if so, what has been the effect as regards the accuracy and endurance of the gun? I must say it is a shame that in these days we should have so few large rifled guns in the navy. I have been struck with reading of the success of the French in cast-iron guns; and I understand that Mr. Bashley Britten has succeeded in rifling cast-iron guns with such success, that they produce good accurate practice with rifle shot; and what is still more extraordinary, that the rifling increases the accuracy of round shot fired from the same gun. I think it is a great point that we should be able to fire round shot from whatever is to be the future gun of the navy; because for almost all sea purposes spherical shot has a great advantage in the ricochet which you will never get from elongated shot. Another point on which I should like to chronicle my opinion is with reference to these monster guns. As a rule, I think that as yet, they are mere artillery curiosities. We have not yet had sufficient experience of their capabilities, except in bursting, to know that a 300-pounder or a 600-pounder will ever make a good weapon of war.

Captain HARRISON, R.A.: There is one remark that Captain Scott made shortly after I came into the room, with reference to which I should like to ask on what authority he obtained his information; because I have heard it distinctly contradicted. He said the French have guns—I do not speak of experimental guns, which I think is very probable—but that they have guns which will penetrate four and a half inches of armour plate at 1,000 yards. I was distinctly told on very good

authority that a French naval officer in this country on being asked that question laughed at it. He said, "We certainly have an experimental gun which has done this amount of penetration: but that we have guns which will do that amount of work, is all nonsense, we have not got them." I was also told that so much faith have the French in rifled cast-iron guns, that they are not allowed to fire them except when in action. Such is the opinion they have of their cast-iron guns. With reference to what Captain Scott has said about the competitive Armstrong guns at Shoeburyness, that they completely differ from the breech-loading service gun; so far as I am informed, it seems to me that in the alteration which has been made, it has been a decided disadvantage; because the competitive breech-loader is inferior in every particular to the one in the service now. On the other hand, I never understood that Sir William Armstrong ever objected to the use of steel. Commander Scott seems to think that the introduction of steel had arisen since Sir William Armstrong left the arsenal. I always understood Sir William Armstrong said, "Let us have steel lining as soon as we find we can rely on steel." Query: up to this time has steel been at all reliable for ordnance to stand heavy charges? Take for instance the Prussian steel gun; the charge for that gun is simply 5 lb. Has Commander Scott information of any large steel guns—I do not mean to say that plenty have not been made—but can he give us any information of the number of rounds those guns have stood, and with what charges? The whole question turns upon that. If he cannot, have we been wrong in using wrought iron guns? for certainly we have not seen yet that steel tubes have been as reliable as those of plain wrought iron.

Rear Admiral HALSTED: With respect to the statement just made by my friend Captain Harrison, I would ask him to be good enough to inform us how it is, in a question which is so absolutely critical between the principles of the Armstrong gun, and the principles of the Whitworth gun, representing the polygonal system, that the Government have not put into the pending competition a single gun of all those for which they have paid hard upon three millions of money? and how it is, that the gun with which Sir William Armstrong is now competing, is so absolutely different from his guns in the services, that no pattern whatever of such guns has ever been previously constructed in this country? The service gun consists of two distinct characters, a long gun and a short gun. Neither the long gun nor the short gun, *i.e.*, neither the long gun built upon the pattern of 1860, nor the short gun built upon the pattern of 1863, are represented at the present moment in that contest against the Whitworth polygonal gun. Captain Harrison himself says that neither of these patterns are there. It certainly seems a very wonderful thing, when Sir William Armstrong is challenged for the first time openly, or rather when he accepts for the first time openly a challenge such as that now pending that then he fails to put forth any single sample of any gun which the three millions have purchased from him for the country. I hope Captain Harrison will explain what he means by the distinct assertion that the service guns are better than those which are now being put forth at Shoeburyness by Sir William Armstrong.

Captain HARRISON: I will repeat what I said. I understood Commander Scott to lay great stress upon the fact that Sir William Armstrong had substituted a different breech-loader for our service breech-loader. My remark was this: that so far as I understood, there was no alteration in principle; inasmuch as the breech-loader now in competition at Shoeburyness was a coil gun simply, with a steel-tube inserted.

Admiral HALSTED: No.

Captain HARRISON: This is what I wished to say, that so far as my information goes, the breech-loader at Shoeburyness is a coil gun with a steel tube inside; that if that were the case, Sir William Armstrong had not departed from his principle, because in the very first letter which he wrote on the subject, and which is published in the Report of the Ordnance Committee that sat in the House of Commons, he distinctly stated, that as soon as steel could be obtained of a reliable nature, he wished to use it as a lining for his gun; that at that time he could not rely upon it; therefore he considered the gun ought to be made of hooped iron. That was my first remark regarding what Captain Scott said, that if it be true that the

present competition gun is a coil gun with a steel tube, I did not consider it a departure from the Armstrong principle. Secondly, that even supposing it was, it did not appear to me that Sir William Armstrong had gained by the change, inasmuch as the breech-loader which he at present uses at Shoeburyness is inferior to our service breech-loader; therefore, that Sir William Armstrong would have done much better to have stuck by his old plan, and have used the service gun.

Admiral HALSTED: Permit me to say, that there is nothing more than your statement to shew that the service gun is better.

The CHAIRMAN: We are not now discussing the Armstrong gun; we are discussing the subject raised by the lecturer, the progress of ordnance abroad. You are making this a personal question.

Admiral HALSTED: Permit me to say, that I do not think you are right in bringing me to book, and saying that I am making this a personal question; I am only answering the speaker.

The CHAIRMAN: I do not think you have a right to speak a second time.

Admiral HALSTED: That is another thing. You stated that I had made a remark that was personal.

Rear-Admiral Sir F. NICOLSON, C.B.: I am afraid that our discussion is becoming very heated; and I am quite sure my friend, Admiral Halsted, would be the last to raise anything like a discussion in which any expression that fell from him, quite accidentally, should be objected to. I think it would be a great pity if in his ardent advocacy of one system of guns, he should make us depart from the rule which our Chairman has laid down.

Admiral HALSTED: I did not make it a personal question. Captain Harrison made a statement which I knew to be wrong. He is misinformed, no doubt. It is not a coil-gun, and I merely asserted that it is not a coil-gun.

Mr. J. W. GIRDLESTONE, C.E.: I should like to ask Captain Scott if the screw bolt alluded to as the invention of Captain Palliser, where the part of the bolt on which the thread is cut is of larger diameter than the other part, is supposed to be new in principle, or in its application only for securing armour plates on ships; I suppose the latter, for I myself once showed on some drawings, not a bolt for armour plates, but a screw, where the part on which the thread was cut was of so much larger diameter than the other part of the screw, by the thickness of the thread; which drawings I laid before the Ordnance Select Committee some two years since.

With respect to Mr. Mackay's gun, which has been mentioned this evening, where the shot rotates by the action of the gas, the projectile used being, I believe, only one and a half diameters in length, I would suggest that even if the gas will give sufficient rotation to such a projectile, which I imagine is too short for general use, that it does not follow that it will give anything like sufficient rotation to a projectile of two and a half or of three diameters in length; the projectile having no grooves of any kind on it.

Captain J. H. SELWYN, R.N.: I am anxious to say a word before this meeting, in view of what has been stated in a leading journal within the last day or two, with respect to the naval action fought off Heligoland. That leading journal took occasion to inculcate, with the authority of one who holds the pen with great ability, but who I doubt has ever held the trigger lanyard, the system of long balls as opposed to "close quarters." I do say it is a most dangerous thing for the naval supremacy of this country, that the very talented members of the press should fancy themselves such authorities on such a subject, as to lay down such utterly false premises, and to draw from them such still more false conclusions. It is dangerous, for this reason: young officers are now perhaps better read in the daily journals than they are in the history of their profession; and they are too apt, with the great mass of the British public, to follow the lead of a gentleman, who sitting at home at ease, fancies himself entitled to write of all things, in all places. It is not many months since, that in this Institution a gallant Admiral, whose age and whose experience entitle him to the utmost attention, got up and distinctly laid down as a rule, what I think most naval men of experience will join him in announcing, that no naval action ever was or ever will be *decided* at long ranges. It is

perfectly true, that owing to that trajectory, which some writers in the journal I refer to, also despise as a piece of professional slang, long range guns will occasionally do considerable damage to ships, when the shot strike them on the decks, but not on the armour; but the gun which cannot pierce armour at 200 yards, cannot be expected to do so at 2,000. If any gentleman connected with the press will be kind enough to watch shot falling at three miles distance, and tell me how many of them strike and where they strike, then I shall be obliged to adopt his opinion, and condemn the tactics of the Austrian frigate in running in between her two antagonists and giving them as much as she could, though in that case, as in almost every other, two to one proved too much for her. Though the Prussian gun-boats took part at long balls, yet we learn that they went away, *hoping* they had done the enemy a great deal of damage, but utterly ignorant as to what that great deal was. If any English officer, having fought an action under such circumstances, were to come home to England, saying he *hoped* he had done a great deal of damage to his enemy; he would not be received with those cheers and acclamations, and those laurels which it is the hope and pride of every English officer to deserve. Captain Dawson said, in the course of his argument against what Captain Scott had stated in his lecture, that the guns which Captain Scott advocated were advocated by him because he was an inventor. Now, I must say that it is not a fair thing in any profession for members of that profession to get up and say that because one of their number has turned his attention particularly to this or that subject, and has arrived at a conclusion which day by day is being demonstrated to be more correct, that he is to be regarded simply as an inventor; that he is advocating his own principles; and that he cares nothing about the public service. I do believe that any officer in that position thinks first how he may benefit the service, and next how he may benefit himself. I am sorry to say that in the majority of instances those who do most for the service spend the most money with the least benefit to themselves. I think it is open to the recollection of every one here present that those guns such as Captain Scott advocated, the old cast-iron guns rifled on a particular principle, have been tried with very considerable endurance.

Captain FISHBOURNE: Not advocated.

Captain SELWYN: Captain Scott has advocated a particular principle of rifling cast-iron guns.

Captain FISHBOURNE: Not cast-iron guns.

Captain SELWYN: I did not say advocates cast-iron guns. I said rifled on the principle which Captain Scott advocates.

Captain DAWSON: I did not allude to his principle of rifling. I did not understand him to advocate his own principle of rifling at all.

Captain SELWYN: Then one of us misunderstood the question. I hope it was myself; because Captain Scott will be happy to hear that there is no objection to his rifling. But that system of rifling is one which, to a mechanical mind, must commend itself, because the whole force is communicated in the direction of the line in which rotation is required. It is at the first blush the great excellence of that form of grooving which has led to its adoption in the Jacob rifle, in small arms, and in other arms of the same character. It has next, that which Captain Dawson admired particularly, the power of firing round balls with the least possible injury, and, moreover, with the least possible windage, which is a very valuable condition. Granted that the edges of the grooves must not be injured, then that is the only groove which, with small windage, is capable of firing round ball. The French gun was adverted to by Captain Harrison as a doubtful specimen. I must say that it appeared in journals whose reputation entitles them to credence on such a subject, that that gun did pierce iron plates of the thickness adverted to by Captain Scott at 1,000 yards.

Captain HARRISON: I referred to guns.

Captain SELWYN: I have yet to learn that the French have constructed any other gun. If one gun will do it, that is quite sufficient for our purpose. We only want to know that there is a gun that will do this at such a distance without being damaged or injured. That it does so with diminished powder charge is very little to the purpose, because the effect produced is what we seek. If Sir William Armstrong

has not infringed upon his principle by adopting a steel tube, may I ask to what thickness the steel tube is to go before the coils are considered eliminated altogether? When are coils to cease to be considered the great feature of Sir William Armstrong's principle, as he has himself announced them to be? and when is the internal steel tube to be allowed to take their place? Again, it is said that Sir William Armstrong was ready to take steel whenever he could get it. Now, at a lecture which I am sorry to say was very thinly attended, given here by Mr. Bessemer, he stated to us, what he has stated long ago to the Government, that he could give them steel of any quality they desired, from the same quality as the best and softest wrought iron upwards to the hardest steel, by a mere alteration of the proportional parts of his materials; that he could do so for the Government at £7 per ton. Was this gentleman not equally well worth considering and treating with as another who professed to give us coils which would never weld, which never could be welded between the bars, and which have failed and will fail as long as they are used? And should we have spent three millions of our money less usefully by giving a proper proportion to the development of a metal which promises us the greatest tensile strength? Captain Scott has given a very able *résumé* of the principal features of foreign artillery; but I must draw attention to the fact that in no instance do we see in the foreign artillery any great improvement or advance upon what we know ourselves, unless it be in those instances where they have taken the most valuable principles of our own inventors, and so far demonstrated the value of them as to induce our Government to send officers abroad to look at guns, the designs for which, if not the guns themselves, were made at home.

Commander SCOTT: I think Captain Selwyn has left me very little to answer. Captain Dawson seems to have entirely misunderstood what I meant. He says I spoke in favour of cast-iron. On the contrary, I spoke of cast-iron being given up as a metal fit for powerful rifled guns. I said the Americans had already commenced the mild steel manufacture, had paid a large sum for the patent to Mr. Bessemer, and had an agent over here to be instructed in the manufacture. I must say I cannot understand the purport of Captain Dawson's remarks. He said, on the one hand, that he wants a big gun for the navy, and, on the other, that he does not want a big gun; and then he said that monster guns with a sufficient endurance cannot be made. He also appears to infer that I do not want to fire round shot; whereas, if he had paid attention to what has been said over and over again in this Institution, he would have learnt that the very principle I commenced with was that we had got a good missile in the round ball; that we knew precisely what it would do; and, therefore, it was folly to give up what we knew was good to go after something else, the value of which we did not know. Besides, I called attention to the fact that the very first trial of the Armstrong gun proved it to be inferior to the 68-pounder at close quarters; and I said that for a naval gun you must have the round ball as well as the elongated projectile, but that the first thing was to fire the round ball well, and in my letter to the War Department in 1859 I stated that "the round ball will always finish naval actions." Although I am one of those whom Captain Dawson has kindly stigmatized as an inventor, I must say, that as one of the early gunnery officers, and having paid such attention to the subject that I was enabled publicly to state in 1860 that the plans of Sir William Armstrong were not adapted for naval guns, it became almost imperative upon me to show that they were so. This endeavour has cost me a considerable sum of money, for I had to pay for all my early experiments, because I happened to be a naval officer instead of a civil engineer. If Captain Dawson could point out to me where I have gained in this matter, I shall be particularly obliged to him. With reference to the remarks as to where the steel is in Sir William Armstrong's competitive guns, the simple fact is that they are steel guns. They have a solid steel barrel all the way through till you come to the trunnions, and there are little coils put on, one apparently for the trunnion-holder, and the others I suppose for a make-weight over the breech. Had the service 12-pounder been so satisfactory as was said, Sir W. Armstrong would scarcely have gone from a good thing to a new plan. But he had not a good thing, for the service guns are continually failing. As I have adverted to this, I had better take the official Report and just glance at the performances of the Armstrong guns at Kagosima, and the mishaps that happened to them.

The Report speaks of precisely the same thing: of the vent-pieces sticking in the bore from the tin cup being forced back over their nozzles, just as Captain Fishbourne showed to have occurred at Newhaven. The breech expands when warm, and then the tin cup is jerked over the nozzle of the vent-piece, which necessarily sticks fast, and cannot be got out without mechanical appliances. This misfortune did not occur to Racehorse's (Captain Boxer's) gun only, but it occurred also to the guns of the other ships at Kagosima. I have only now to explain about Captain Palliser's bolts.

Captain FISHBOURNE: And the French gun?

Captain SCOTT: As to the French gun, Captain Harrison has one report and I have another, and I believe mine to be correct. Captain Harrison likewise spoke of the Prussian steel gun as not reliable. I am informed that the Prussians are making them in large numbers, and hence I conclude that they are good guns. They are just like those from Krüpp, which have been so successful in English trials. I got the information as to the performance of these guns from different sources; and I also got information from America and other places, of their artillery, but still it is extremely difficult, as Captain Harrison knows, to get information which can be fully relied on. I have no official report, as I have in the case of the Armstrong guns at Japan.

Captain HARRISON: The only question is whether the Prussian guns are making or made?

Captain SCOTT: Making. I was informed that they were going on with them as fast as possible.

Captain HARRISON: Not made?

Captain SCOTT: I have no doubt several of them are by this time, but how many I cannot say.

Sir F. NICOLSON: Have they all been tried?

Captain SCOTT: Several have been tried. As to the "raised screw thread," Captain Palliser only applied the plan for holding armour-plates, and I think great credit is due to him for this novel application of a principle, which is all he claims. It has been, as far as yet tried, eminently successful. I think I have now answered all the questions, in which Captain Selwyn, like a true sailor, has not only kindly helped me onward, but cheered me on the road.

The CHAIRMAN: It only remains for me to ask you to join me in thanking Captain Scott for his lecture. Lectures of this description take about an hour and a half to deliver, but I am sure they take many hours to study and to write. We see the wheat after it has been sifted through the sieve. Captain Scott has been sifting the wheat for us, and it is rather a long process. As Englishmen, I think we may be satisfied with what he has shown us. We seem to have gone through a long course of experiments, gradually and gradually improving; and it is satisfactory to know that all the countries,—France, Russia, Austria, Prussia, except Italy, Spain, and Portugal,—have gone through the same course of disappointment, and have worked their way up to their present position.

NATURE OF GUN.	Powder charge.	PROJECTILES.			Velocity at 30 yards.	Initial velocity.	Remarks.
		Nature.	Weight.	Diameter			
	lbs.		lbs.	in.	ft.	ft.	
32-pr. Rifled Shunt, 59 cwt., cast-iron gun	5·8	Elongated shell	54	6·35	1215·7	1224·5	Mean of 4 rounds.
„ „ „	5·8	„ „	54	6·35	1122·1	1136·3	Mean of 3 rounds.
32-pr., 59 cwt., Smooth.....	5·8	Cylinder	54	6·35	1187·4	1201·0	
12-pr., A, 8½ cwt.	1·6	Elongated shell	11·9	3·074	1103·4	1111·8	
„ „	1·8	„ „	11·9	3·074	1238·3	1248·2	
„ „	1·8	„ „	11·9	3·010	1200·	1209·7	Same shell, lead reduced to the same diameter as the gun, except a ring 0·25 of an inch in length at the base.
68-pr., 95 cwt.	16·	Round ball	66·4	7·91	1553·3	1579·0	
„ „	„	Round shell	51·8	7·91	1769·4	1809·9	
32-pr., 58 cwt.	10·	Round ball	31·6	6·17	1653·	1690·0	
12-pr., 18 cwt.	4·	„	12·10½	4·52	1718·	1769·8	
12-pr., 6½ cwt.	1·4	Elongated shell	8·12	4·55	1124·2	1163·4	
12-pr., A., 8½ cwt.	1·8	„ „	11·9	3·084	1180·9	1190·2	

NATURE OF GUN.	Powder charge.	PROJECTILES. Nature.	Weight.	Diameter.	Velocities.	
	lbs.		lbs.	in.	ft.	
Horsfall's Smooth Bore {wt. 24¾ tons, bore 13·014 in.}	74·45	Round ball	279·5	5	1631·0	Initial.
300-pounder {shunt / rifled} {wt. 12 tons, bore 10·48 in.}	50·0	„	150	10·41	1750·0	„
„ „ „	50·0	„ wrought iron ..	162	„ „	1700·0	„
„ „ „	45·0	„ „ ..	163	10·337	1627·0	At 508 feet from gun.
„ „ „	50·0	„ steel	168¾	10·43	1593·8	At 510 feet from gun.
„ „ „	45·0	Elongated steel shot...	301	10·46	1254·5	„ „
„ „ „	35·0	„ cast iron	308	..	1096·0	„ „
Lynall, Thomas {wt. 18 tons, bore 9·0 in.}	50·0	„ steel.....	327	..	1222·0	At 546 „
Shunt rifled {bore 9·22 in., wt. 12½ tons.}	44·0	„ „	221	9·14	1461·1	At 510 „
„ „	30·0	„ „	221	9·14	1292·6	„ „
„ {bore 7·0 in., wt. 6½ tons.}	25·0	„ „	100	6·91	1507·2	„ „
Big Will, 600-pr. {bore 13·3 in., wt. 22¾ tons.}	90·0	Round ball „	344	..	1589·0	At 600 „
„ „ „	70·0	Elongated shot, cast-iron	513	13·25	1255·0	At 120 „
„ „ „	70·0	„ shell, steel ..	610	..	1143·0	At 2910 „
„ „ „	70·0	Round ball, cast-iron ..	304¾	13·2	1273·3	At 510 „
Committee Gun for lead-coated shot of Messrs. Britten & Jeffrey {bore 7·1 in. wt. 6 tons.} ..	16·0	Elongated shot, steel ..	119	..	1273·3	„ „
Whitworth's 120-pr. {bore 7 × 6·4 in., wt. 7½ tons.}	27·0	„ shell „ ..	149·5	..	1283·4	„ „
„ „ „	23·0	Elongated shot „ ..	129·0	..	1278·5	*At 1740 „
„ 70-pr. {bore 5·6 × 5·2 in., wt. 3¾ tons.}	12·0	„ „	68·8	..	1275·8	Initial.
Scott's 120-pr. {bore 7 inches, wt. 7½ tons.}	25·0	.. ..	110·0	..	1584·0	„
„ „ „	12·0	.. ..	110·0	..	1270·0	„
French „ „	25·0	.. ..	110·0	..	1550·0	„
„ „ „	12·0	.. ..	110·0	..	1256·0	„
Parrott's 100-pr., bore 6·4 in.	11·0	.. ..	80·0	..	1405·0	„
Rodman's 15-inch, bore 15·0 in.	60·0	Round ball, cast iron ..	400·0	..	1480·0	„
„ „ „	40·0	„ „	315·0	..	1250·0	„

The Journal

OF THE

Royal United Service Institution.

Vol. VIII. 1865. Appendix.

PROCEEDINGS OF THE THIRTY-FOURTH ANNIVERSARY MEETING.

The Thirty-fourth Annual Meeting of the Members was held in the Theatre of the Institution, on Saturday the 4th March.

His Grace the Duke of Somerset, K.G., First Lord of the Admiralty in the Chair.

I. The Secretary read the Notice convening the Meeting,

II. The Minutes of the Proceedings of the Thirty-third Anniversary Meeting were read.

III. The Minutes of the Proceedings of a Special General Meeting held on Monday May 2nd, 1864, were read.

IV. Captain Sir John Hay, Bart., R.N., M.P., F.R.S.—

The Report which is about to be presented to you will naturally attract some attention on account of one omission. Since it was prepared the Institution has had the misfortune to lose its President, the late Duke of Northumberland, and it was only in consequence of the fact that the Report was printed, and was in a position to be submitted to the meeting, that it was not thought advisable by the Council to have it altered and reprinted for the purpose of calling attention to that great loss. But I think if the course which I, as Chairman of the Council, would venture to recommend to the meeting be adopted, perhaps even a greater mark of respect will be shown to the memory of our late President. You are well aware of the fact of the great interest which our late President took in all scientific matters connected with the Navy. Holding very high rank in that profession, and having served with some distinction as a junior officer up to the time of his becoming a captain, at the close of the late war, his memory was remembered with great satisfaction in the Navy. From that time his duties as a large landed proprietor, combined with his love of science and the absence of any services that would require his active presence afloat, led him to devote his life to other avocations. But his connection with the Navy was still maintained, because it will be in your recollec-

tion that during the years 1852 and 1853 he held the office of First Lord of the Admiralty. He was also a most munificient patron of this Institution. Several considerable donations have been given by him towards the completion of this Theatre, and towards the model of the Battle of Trafalgar. In 1841 he gave us a large collection of maps, and in 1850 a collection of arms, models, and astronomical instruments. What we therefore propose to do in recollection of his services and his connection with this Institution, is to ask this meeting to adopt an address in the form of a letter of condolence to his widow, the Duchess of Northumberland. If the meeting will allow me, I will read the form of letter which has been adopted by the Council to be submitted to you; and if it should be, as I trust it may be, adopted unanimously by this meeting, we would ask your Grace to place it in the right channel.

"Madam,

"The Council and Members of this Institution desire to express to your Grace the great sorrow which they feel for the death of their late President, and to condole with you on your irreparable loss.

"During many years his position as their honoured head has been a tower of strength to this Institution.

"His kind courtesy, and his munificent patronage, and love of literature and science, alike endeared him to both the Army and Navy, and the memory of the late Duke of Northumberland will long be treasured by the Members of the Royal United Service Institution."

What I, therefore, have to do is to propose this Resolution:—

"That this meeting do adopt this Address of Condolence to her Grace the Duchess of Northumberland on the death of his Grace, the President, and that his Grace the Chairman, be requested to communicate the same to the Duchess."

Lieut.-General the Hon. Sir EDWARD CUST, K.C.H.—

My Lord Duke, it is a melancholy gratification to me to be called upon to second this Resolution, inasmuch as the Duke and Duchess have been my personal friends for a great many years. I had a sincere regard for him personally, and have enjoyed his hospitalities both in town and country. And I esteem most sincerely the Duchess to whom we are about to offer this address. She has some claim to share the good actions of her husband, for she was renowned even before her marriage, for her active and zealous desire to do good in every possible way. It was this benevolence of her character, which was, I believe, the origin of the acquaintance between them. And there is no doubt that, even to the last, her anxiety to be an excellent wife was shown in the desire to do the duties of a nurse, until it was actually required by the physicians that she should relinquish the office to another person. I would also beg leave to add a few words upon the character of the Duke, because he has really acquired a place in the thoughts of every one throughout the country, and with very great justice too. It is well-known to you all, that it is an old custom at the funerals of the great nobility for the herald to proclaim the style and titles of the deceased nobleman. There is no doubt the names of Percy, Lucy, Poynings, and Latimer, and all the titles which rested on his Grace's head, were interwoven with the history of this country, and with the ballad music and literature of England. But I do think that the heraldic style and titles of the Duke of Northumberland, great as those titles were, sink into utter insignificance and may be passed over, when compared with such style and titles as these:—"The late Duke was a Fellow of the Royal Society, of the Society of Antiquaries, of the Royal Geographical Society, and a member of the Royal Astronomical and other learned societies. He was also a munificent supporter of many of our charitable institutions, was President of the Westminster and Middlesex Hospitals, Vice-Patron of Charing Cross Hospital, President of the Seamen's Hospital Society, President of the Westminster General Dispensary, Vice-President of the Royal Humane Society, President of the Royal National Life Boat Institution, Vice-President of the Royal Naval Benevolent

Society. His Grace was also President of the Royal United Service Institution, President of the Royal Institution of Great Britain, a Director of the British Institution, and a Trustee of the British Museum." The Duke of Northumberland, as Sir John Hay has stated, was not, after he retired from the service, at all one of that class of gentlemen of England "who live at home at ease," and care nothing for "the dangers of the seas." Subsequently to that period his life was passed in every possible way connected with the profession.

"His Grace was very anxious, when he found his health was failing, to complete a large and magnificent scheme that he had long contemplated, for the education of the children of fishermen and seamen on the coast of Northumberland, and it is stated that the endowment of schools in the villages of Whitley, Tynemouth, Percy Main, and at North Shields, was completed before his death. The Duke of Northumberland built the Tyne Sailors' Home at a cost of upwards of 7,000*l*. He also established life-boats and life-boat stations at Hauxley, Tynemouth, Cullercoats, and Newbiggin, and was a magnificent supporter of all local charities." In fact, the whole of his career seems to have been that of a noble sailor. It may be said of him that he carried his uniform not only on his back but in his heart. Nor was it only to subjects of this kind that the Duke lent his attention, he was a great lover of science, and he was a remarkable traveller. Indeed, it may be said of him emphatically, that "he was learned in all the wisdom of the Egyptians." He was among the first who went up the Nile and examined Thebes and all those places which are now so commonly visited as to have lost part of their interest. And if I am not misinformed he brought from that country, and enriched with it the national collection at the British Museum, one of the oldest marbles known, a marble, supposed from his knowledge of Egyptian hieroglyphics, to have the mark of the cartouche of the Pharoah of Moses. These facts evidently show that he was by no means an ordinary kind of man. We all feel that when men of high station condescend to make themselves useful in their profession, that they are entitled to the esteem of their fellow-countrymen. And I am sure, my Lord Duke, that by none are such men esteemed more than by yourself, who in an office comparatively strange to you, have brought to it an intelligence, an activity, and an industry which have obtained for you the confidence and esteem of the Naval profession.

The Resolution was put from the Chair and carried unanimously.

The Duke of SOMERSET—

I shall of course feel it my duty to communicate this address of condolence to the Duchess of Northumberland. With reference to the late Duke, it is unnecessary that I should say a word, because the feeling with regard to him is so general and profound. I can confirm, however, what has just been spoken by Sir Edward Cust, because being myself a Trustee of the British Museum, I can bear testimony to the liberal gifts that his Grace has made to that Institution, doing that which only his Grace's wealth and liberal mind, combined with knowledge really appreciating what was valuable in that Institution, enabled him to do.

V. The Annual Report of the Council was read as follows:—

1. In submitting this, their Thirty-fourth Annual Report, the COUNCIL have the pleasure of congratulating the Members on the increasing prosperity of the Royal United Service Institution.

MEMBERS.

2. The number of Members who joined the Institution during the year amounted to 215. The loss by death has been 100; 53 have withdrawn; and the names of 7 have been struck off the list, their

subscriptions for upwards of two years, though more than once applied for, remaining unpaid. The increase on the year therefore is 55. A detailed statement of the changes amongst the Members, and a tabular analysis of the present and past state of the Institution, will be found at pages xvi and xvii.

Finance.

3. The usual Abstract of the Yearly Accounts, as audited on the 27th of January, is given on the following page.

Receipts.

4. The Receipts have exceeded the estimated amount by £419. The annual subscriptions above 10*s.* have amounted to £137 beyond the estimate; the entrance fees to £65; and the sale of the Journal to £38. The sum of £9 has been received in donations.

GENERAL ABSTRACT OF THE ACCOUNTS OF THE ROYAL UNITED SERVICE INSTITUTION FROM 1st JANUARY to 31st DECEMBER, 1864.

EXPENDITURE.

	£	s.	d.	Amount. £	s.	d.
Secretary's Salary				200	0	0
Accountant's ditto				90	0	0
Clerk's ditto				52	0	0
Servants' Wages				344	14	6
Ditto Clothing				44	19	6
Insurance				29	5	0
Fuel				64	8	6
Lighting				33	6	10
Ground Rent				205	3	9
Assessed Taxes				75	15	11
Parish Rates				94	5	0
Water Rate				10	0	0
Annuity to Malcolm				20	0	0
Journals				687	11	10
Postage { Journals	140	1	8			
Postage { Letters	27	7	0			
				167	8	8
Library				116	18	11
Museum				71	10	11
Topographical Room				21	17	6
Advertisements				41	17	5
Artificers				85	14	5
Lectures				39	11	9
Printing Circulars and Stationery				71	13	5
Receipts and Postage Stamps				3	1	1
Miscellaneous				17	3	1
Domestic Sundries				17	13	10
Petty Cash returned to Bankers				3	15	10
Total Expenditure				£2,609	17	8
Cash repaid to Agents				17	2	6
Charges from ,,				1	17	10
Invested in purchase of Stock				212	0	0
,, ,, 5 per Cent. India Stock (Reserved Fund)				723	12	6
Balance at Bankers, 31st December, 1864 { Income	76	14	9			
Balance at Bankers, 31st December, 1864 { Life	53	0	0			
				129	14	9
Total				£3,694	5	3

RECEIPTS.

	£	s.	d.	Amount. £	s.	d.
Balance at Bankers, 31st December, 1863				172	3	3
Annual Subscriptions, at 10s., for 1864	666	15	3			
,, ,, above ,,	1,737	2	6			
,, ,, arrears	8	10	0			
,, ,, advance	13	10	0			
				2,425	17	9
Entrance Fees				215	0	0
Dividends				103	18	1
Donations				9	0	0
Grant from Government				400	0	0
Sale of Journals				98	1	4
Sale of Waterloo and Sevastopol Models Pamphlets				1	9	0
Balance of Petty Cash returned to Bankers				3	15	10
				£3,429	5	3
Balance of Life Subscriptions in hand, 31st December, 1863				43	0	0
Life Subscriptions received during 1864				222	0	0
Total				£3,694	5	3

Examined and found correct, J. E. A. DOLBY, THOS. SMITH, H. F. DOWNES, J. D. MACQUEEN, Captain, } Auditors.

27th January, 1865.

GEO. FELSTEAD, Accountant.

ESTIMATE OF PROBABLE RECEIPTS AND EXPENDITURE FOR 1865.

EXPENDITURE.	Amount. £	s.	d.
Secretary's Salary ..	200	0	0
Accountant's do	90	0	0
Clerk's Salary	52	0	0
Servants' Wages	370	0	0
Servants' Clothing ..	45	0	0
Insurance	29	5	0
Fuel	65	0	0
Lighting	35	0	0
Ground Rent	205	10	0
Assessed Taxes	100	0	0
Parish Rates	100	0	0
Water Rate	10	0	0
Annuity to Malcolm ..	20	0	0
Journals	700	0	0
Postage thereof	150	0	0
Library	100	0	0
Printing Catalogue thereof	250	0	0
Museum, including Models of Ships, Guns, &c. ..	250	0	0
Topographical Room ..	50	0	0
Advertisements	40	0	0
Artificers	100	0	0
Lectures	50	0	0
Printing Annual Report and List of Members ..	80	0	0
Printing Circulars, Stationery, &c.	80	0	0
Postage	40	0	0
Receipt Stamps	3	0	0
Miscellaneous	50	0	0
Domestic Sundries ..	20	0	0
	£3,284	15	0
Balance ..	45	5	0
Total.. ..	£3,330	0	0

RECEIPTS.		Amount. £	s.	d.
Annual Subscriptions :				
At 10s. .. 670	0 0			
Above .. 1,700	0 0			
		2,370	0	0
Entrance Fees		150	0	0
Dividends		150	0	0
Sale of Journals		60	0	0
		£2,730	0	0
Grant from Government .		600	0	0
Total.. ..		£3,330	0	0

EXPENDITURE.

5. The Expenditure has fallen within the estimate by £368. In the publication of the JOURNAL (including the Report and List of Members), by £163; in the Library, by £54; Museum, £29; Topographical Department, £29; Artificers, £55; and Miscellaneous Expenses, by £33.

During the past year, the COUNCIL, by reducing the Expenditure of the Institution so far as compatible with the efficient administration of its affairs, have been able to invest the sum of £700 in India Five Per Cent. as a "Reserved Fund," whilst the question of Building, which would entail a large outlay, is in abeyance.

LIFE SUBSCRIPTIONS.

6. The balance of £43 at the end of 1863, and the Life Subscriptions received during 1864 amounting to £222, have, with the excep-

tion of a balance of £53, which will be similarly dealt with, been invested in Government Securities.

The funded property of the Institution in Three Per Cent. Consols and Five Per Cent. India Stock amounted on the 1st January, 1865, to £4,516 16*s.* 4*d.*

Government Grant.

7. The Council have great satisfaction in informing the Members, that in answer to an application requesting, on behalf of the Naval Service, a contribution from the Lords Commissioners of the Admiralty towards the funds of the Institution, they have received a communication that their Lordships propose to subscribe annually £300, on the understanding that a similar grant be made in the Army Votes; and that the Lords of the Treasury have been requested to sanction the insertion of that sum in the Naval Estimates for the year 1865–66.

From the Right Honorable the Secretary of State for War, the Council have received intimation that, instead of the grant of £400 hitherto made, only £300 will be provided in the Army Estimates, but on the understanding that a similar sum be also contributed from the Naval Funds. To this arrangement, as explained above, the Lords Commissioners of the Admiralty have agreed; and the Government grant has thus been raised from £400 to £600 per annum.

It is a subject of congratulation that the Institution is now substantially recognised by the Naval as well as the Military Departments of the country; and the Council take this opportunity of expressing their best thanks to those Departments.

Lease of the Premises.

8. The lease of the front portion of the premises occupied by the Institution having expired on the 5th April 1864, the Council entered into an agreement with the First Commissioner of Her Majesty's Woods and Forests to occupy that portion at the former rent of £205 10*s.* per annum, paid quarterly, the occupancy to terminate on a quarter's notice given by either party. No official information has been received by the Council as to whether the present site will be granted by the Crown; but the Council have reason to hope that the present site may be retained, with an offer of increased space. Should such be the case, and a new street from Whitehall to the Thames Embankment (by which the position of the Institution would be greatly improved) be opened, the Council will submit to the Members a plan for the erection of an improved building. A scheme for raising the necessary funds will be brought forward when the arrangements have been further developed.

The Journal.

9. The Council have, in former reports, expressed their opinion of the great importance of this publication, and each year strengthens them in that conviction. Not only is it more and more appreciated by the Members, but its increasing sale proves the greater estimation in which it is held by the public.

It may fairly be stated, that the Journal forms a considerable, if not the chief, inducement for Officers of the Services to become Members; conveying, to them, as it does, at a distance from the metropolis, or whilst serving abroad, special information on the naval and military questions of the day which they are unable to obtain from any other source.

The value of the Journal would, however, be much enhanced if Members of scientific attainments residing at a distance, and not having the opportunity of themselves reading papers at the Institution, would forward memoranda suitable for the Lecture Room or for publication.

The Lectures.

10. The Lectures delivered and papers read during the past session, have been as valuable as those of any former session; and the Council tender their thanks to those gentlemen who have placed their time and talents at the disposal of the Institution. The importance of affording to the Officers of Her Majesty's Services, and scientific men generally, opportunities for meeting and discussing the varied questions connected with the Naval and Military professions, cannot be overestimated. These discussions, at a time of great scientific progress, have proved of signal value to the Public Departments of the country.

Library.

11. In making additions to this valuable branch of the Institution, the Council have exercised considerable economy during the past year, but they are of opinion, that the time has now arrived, when, with the prospect of sufficient funds, it is highly desirable that a want long felt, viz., the printing of a new Catalogue, should be supplied; and they have taken this subject into consideration in framing the estimate of expenditure for the current year.

Topographical Department.

12. Satisfactory progress has been made in arranging the valuable maps and plans in this department. This important work was most kindly commenced and carried on by Staff-Commander Bailey, R.N., to whom the best thanks of the Council are due; but much remains to be done. A Catalogue has been commenced, and the Council trust that it will be completed, as well as the improved arrangement of the department, before midsummer.

The practice of marking the positions of armies in the field, on maps in the Topographical Room, has been continued for the convenience of Members. The Council hope, by this system, to have removed some of the hindrances to a ready and careful study of military operations in the field.

Museum.

13. Several additions by presentation have been made, and thanks returned to the Donors. Some valuable additions have also been made to the specimens of defensive armour. Several models of guns

(on a uniform scale) have been added, and it is the intention of the Council to make this collection as complete as possible. It appears to be a matter of great importance that a facility for comparing the various guns should be afforded at a time when they are of so much interest. For this reason, and to supply the great deficiencies in the series of naval models, a much larger sum than usual has been appropriated for this department of the Institution. A record of the various additions will be found in the Appendix to Vol. VIII. of the Journal, as also of those to the Library and Topographical Departments.

Special General Meeting.

14. By the sanction obtained at a Special General Meeting held on Monday, May 2nd, 1864, Section II., Paragraph 1 of the Bye-laws was altered, so as to entitle the Officers of the Royal Naval Reserve to become Members without ballot. The Council are sure that the Members generally will welcome amongst them the valuable Officers of that Corps.

Honorary Members.

15. General Todleben, of the Imperial Russian Engineers, was elected an Honorary Member, on the occasion of his recent visit to this country. Count Maffei, of the Italian Legation, has also been elected an Honorary Member.

Corresponding Members.

16. At the commencement of the current year, there were 246 Corresponding Members of Council, being an increase of 64 during the past year. The Council consider it of the highest importance to the Institution, that its interests should be thus represented, amongst the various branches of Her Majesty's Naval and Military Forces. Whilst thanking the Corresponding Members for the aid already so efficiently rendered, the Council would point out that much still remains to be done to obtain that universal support which the Institution may justly claim.

Conclusion.

The Council have only further to observe that the advantages afforded by the Institution have now been fairly recognised, and its national importance fully established; and they are confident that the Members may look forward to a career of enlarged usefulness and increasing prosperity.

Colonel J. Clark Kennedy, C.B.—

My Lord Duke, and Gentlemen,—It is well known that many officers of the United Service are somewhat given to join in sundry speculations. Probably there are present on this occasion many who are connected with the various institutions and companies of the day, either as directors or as shareholders. Let us hope, for their sakes, that the companies are all limited. But those gentlemen, accustomed as they must be to their own general meetings, will, I fear, find our general meeting of to-day somewhat tame in comparison. At those meetings they find the defiant oiliness of the Directors; they find the candid Secretary, with his accounts that no one can understand; and they find the chronic growls of discontented shareholders.

Here at our general meetings nothing of the kind can occur. Our Council or Directors are here, I am sure, to receive the thanks of the whole of the members, for the manner in which they have conducted the affairs of the Institution. Our Secretary is here, with his accounts drawn out in so clear a way, that "he who runs may read;" and we understand he is here as such, and not to act as a medium between the Council and ourselves; but is also here, I trust, to receive the proper recognition due for his services to the Institution. And we as the members are here, not to growl, but to express our perfect satisfaction and our delight at the increasing prosperity of this Institution. There are one or two points to which, perhaps, I may be permitted to allude. The first is the most important of all, our financial condition. There is no necessity for my going into the figures, as they are already in every gentleman's hands. But I may draw attention specially to the point that our receipts have exceeded our estimate by upwards of £400, and that our expenditure has fallen short of our estimate by £368; thus, enabling the Council to fund a sum of £700, a sum of tenfold more importance to us now than it has been before, as we are now liable to be so far moved from a portion of the premises, that at least one half of the house will have to be rebuilt. Our financial condition has been somewhat affected by our losses and gains during the year. Our loss has been, I believe, rather more than the average. We have lost by death 100 members; 53 have retired for unavoidable reasons, but I think we may congratulate ourselves that out of nearly 4,000 members scattered over every part of the world, there are only seven gentlemen who have not paid up. Next to our financial condition, and, indeed, intimately connected with it, is the announcement which has been made this day, that the Lords of the Admiralty have agreed to share with the War Office the charge of the subsidy which we receive from Government, a subsidy which we may truly say, without any self-praise, we fairly earn from the country. In addition to the increase to our funds from the Admiralty Grant, I think we ought specially to take notice, that it is a public recognition from the Admiralty of our usefulness. With regard to the renewal of our lease, we may well leave that matter in the hands of the Council. We need be under no anxiety as to being removed from our present situation, which suits us and the public so well. However, if eventually there should be any difficulties, I think we may safely leave the matter in the hands of His Grace the First Lord of the Admiralty, and of his Lordship the Secretary of State for War. I do not think it at all likely, whatever defence the First Commissioner of Woods and Forests may make, that if he is placed between the double fire of the Army and Navy on one side, and the Admiralty and the War Office on the other, that he can possibly hold his position. We leave to those two departments their choice of guns and their choice of ammunition, without any discussion on the part of those in this room. Our *Journal*, which has taken a very prominent position in our proceedings, has this year had a more satisfactory distribution than it has ever had since the first day it was commenced. There was an estimate made last year of the sale of the *Journal*, which has been exceeded by a sum of £38, being an increase of 76 per cent. upon the original estimate. Although I dare say there are many practical minded gentlemen present who look upon that £38 as an important addition to our funds, still I have no doubt there are many others who will regard it, not as a mere sum of money, but as representing the success of the *Journal* in its increased circulation, and I trust also in its increased usefulness. With regard to the *Journal* itself, the contents of the volume for the past year has been more varied, and I may say of more value than heretofore. Almost every subject of interest to sailors and soldiers has been more or less touched upon and discussed, either in the lectures and papers which are given in this theatre, or in the communications from contributors which appear in the *Journal*. Every subject almost that you can think of connected with the services has been brought before us. From strategy to small arms, from shipbuilding to the slinging of a knapsack, from the quality of steel to the lining of a soldier's jacket, nothing has been forgotten; everything of interest to us, so far as the time would allow, has been fully and fairly discussed in the *Journal*. With regard to one of the great objects of interest of the day, The battle of the Guns, those who have been present at the various discussions here may well say that in this room the discussion has taken place with less

noise, with more knowledge than elsewhere, and with at least equal practical results. There has been one addition made to our general rules, in the admission without ballot of the officers of the Royal Naval Reserve, which was carried unanimously on a previous occasion at a Special General Meeting; still as that meeting was not of the same extent as this, I think we may take the opportunity to express our gratification at having these officers made eligible to become members of our Institution without going through the form of ballot. With regard to our library, our museum, and our professional collections, no remark from me is required; nothing can be more satisfactory than the state of the Institution generally. I am afraid I have already detained you too long; therefore, I will conclude, before moving the adoption of the Report, in the very words of the Council themselves, which should be echoed by every member of the Institution present, namely, "That the advantages afforded by the Institution have now been fairly recognised, and its national importance fully established, and they are confident that the members may look forward to a career of enlarged usefulness and of increasing prosperity." I beg to move the adoption of the Report.

Rear-Admiral OMMANNEY—

I beg to second this Resolution. The proposer has touched so fully upon the different topics in the Report, that it is unnecessary for me to say anything. The prosperity of the Institution is so apparent by the Report laid before us, that I am sure every member of this Institution will receive it with great gratification.

The Resolution was put from the Chair, and carried unanimously.

VI. The names of the eight Members retiring from the Council by rotation were read as follows:—

Captain E. PACKE.
Captain H. W. TYLER, R.E.
Commodore A. P. RYDER, R.N.
Captain M. PETRIE.
Captain W. D. MALTON.
Rear-Admiral E. G. GOLDSMITH, C.B.
Captain Sir JOHN C. D. HAY, Bart., R.N., M.P., F.R.S.
Captain J. W. TARLETON, R.N., C.B.

MONTAGU CHAMBERS, Esq., Q.C.—

My Lord Duke, and Gentlemen,—It may seem somewhat presumptuous that almost an unknown person should address so many veteran and superior officers; but obedience is the essence and strength of our United Service, and it is simply in obedience to orders that I hold in my hand a Resolution that I am quite sure will meet with the approval of all who are here present. It is a Resolution of gratitude; and gratitude is a duty that belongs not only to the United Service, but to all Englishmen who have received benefits. I will direct your attention for a few minutes, if you please, to some remarkable circumstances connected with the history and progress of this prosperous Association. It commenced with small beginnings; unostentatiously, quietly, but steadily, it has made its way; it has gradually advanced and gained strength until it has become a great national benefit. Strangers as well as subscribers derive advantages from its proceedings, and sorry am I to confess that here I myself am almost a stranger, and from my inability to attend frequently your lectures and discussions, can only acknowledge that I have been greatly benefited and instructed by receiving from time to time in the shape of your *Journals* the most interesting and important information that can be given to one who cherishes the memory of the Military Service, from the active duties of which by necessity alone, he has been compelled to retire. I think we ought all, (for although serving but a very short time, I venture to associate myself with you), to feel an honourable and just pride, that by our own exertions we have succeeded in raising our Association to its present high position, and have obtained for it, without solicitation, but by our own efforts, the recognition of the authorities as an exceedingly useful and valuable national Institution. Some passages in the Report have been particularly noticed by a preceding eloquent speaker, but it cannot but have struck

you all, that at the same time that we have been growing and increasing in strength, we have also acquired and possess "the sinews of war." Without these—I allude to financial means—it is next to impossible to succeed in any undertaking. We have set a very good example indeed, which perhaps might usefully be followed elsewhere; for it appears on looking to the estimates of probable receipts and expenditure for the past year that the expenditure has been much less, and the receipts much larger than were anticipated; so that our balance-sheet,—and I believe this has happened almost every year since we attained considerable prosperity, presents a large surplus to be devoted to savings or to future useful purposes. This is a very important matter; and certainly it does and must appear to strangers and to all who take an interest in this Institution, that its originators and those members who by their exertions have contributed to these results, are deserving of all honour for the services rendered. This has led me to enquire and to suggest by what means all this has been accomplished. By the ordinary means which will invariably ensure success, the devoted attention, the prudent assiduity, the knowledge, and experience of those to whom we have entrusted the management of our affairs. Who are they? They are the Council. I hope we shall ever recollect our obligations to the Council who have acted in former times, and that we shall now be prepared to recognise those who have served us so well during the past year, and those who are willing to act for the present as our great benefactors, and deserving of our grateful thanks. The Resolution I now propose embodies the sentiments I have endeavoured to express. It is this:—

"That the thanks of this Meeting be given to the members of the Council who retire by rotation, and that the following gentlemen be elected to fill the vacancies:—

Captain E. Packe.	For Re-election.	Lieut.-Col. J. H. Le Conteur, Coldstream Guards.
Captain W. H. Tyler, R.E.		Captain R. Hall, R.N.
Captain Sir John D. Hay, Bart., R.N., M.P., F.R.S.		W. F. Higgins, Esq.
Major A. C. Cooke, R.E.		Rear-Admiral E. G. Fanshawe.'

Colonel Dunne, M.P.—

My Lords and Gentlemen,—I rise with great pleasure to second the motion which has been proposed by my learned and gallant friend who sits near me. To myself—for I believe I was one of the earliest members of the Institution—it is most gratifying to see the change and advancement we have made in the prospects of this Society. I recollect when our funds were only £640 a year, and now they amount to between £3,000 and £4,000, with £4,000 in stock. But the prosperity is a great deal more apparent when you consider the usefulness of the Institution. I recollect when in the English language there was scarcely any book that a military man, wishing to improve himself in the science of his profession, could consult; we were then obliged to have recourse to French publications, and very admirable works they were too. I recollect in early life, when I first entered the Army, I formed the wish that we ourselves should be able to compete with the French in scientific attainments, and in the exposition of those attainments; and I think we have succeeded. I am happy to say that our *Journal* has improved, and is worthy of being read. I hope we shall still go on improving our works of a scientific nature in connection with military art. I am certain that publications of this kind stimulate the efforts of young men in the Army, for any man reading in the *Journal* a paper that has received praise, becomes anxious that he himself should do something; he studies his profession, and embodies the result in a paper that probably surpasses the one which first excited his emulation. I am not one of those who are so wildly mad on the subject of competitive examinations; but I do think that one of the great objects of the profession should be, that the men who embark in it should be perfectly fitted for the purpose to which they are called upon to devote their talents; and I think the lectures and discussions which are given in this Institution necessarily contribute to that desirable end. There are one or two points in the Report that I will allude

to, and to which I will call the attention of the meeting. It has always struck me that the first would be very useful in connection with the Society; the matter is now only partially carried out. I allude to sections XII and XVI, which relate to the maps and corresponding members. I do not think any country in the world should possess more geographical knowledge than Great Britain. We have our armies and our fleets scattered over the whole world; and I think every encouragement should be given to members serving abroad to send in plans of positions and geographical plans which they may have the opportunity of procuring in any part of the world. It has been done to a certain extent. I know myself, when I have been quartered in various parts of the world, that many officers with time to spare, and qualified for surveying, have formed plans which would be most valuable if received in this country. In the Depôt de la Guerre, at Paris, you will find an immense number of plans of this nature. I am perfectly certain that they are most useful, and that no country could equal ours in the collection of plans we could possess, if the suggestion I have thrown out were more generally acted upon. No doubt there would be many plans that might not be worth keeping; but the Council of this Institution, or those to whom the task might be assigned of examining them, could make a selection of those which it would be worth while to retain. At the beginning of the Crimean war I know, for I had the opportunity at the time of knowing, that very little of the ground, even round Constantinople, was known. Yet I know that there were plans in the possession of private individuals; I had some myself, which I gave to Lord Hardinge. Such as these might be procured and kept for future purposes in our Repository. I merely throw out the suggestion to the Council. It is a subject to which I have all my life turned my attention, and I simply submit it to the consideration of those who guide the administration of the Institution. That administration is in the hands of the Council, and I am certain that no gentleman present will refuse to accord to them the praise which is due for their attention, and for the condition of prosperity to which they have brought this Institution. From a low ebb, without any assistance from the Government, and without attracting any great attention from the public or the profession, they have brought the Institution to the position in which it now stands, and in which it is recognised by the Government. I do not believe that any portion of the Naval and Military Estimates voted by the House will be more usefully employed than the Grant of £600 to the Royal United Service Institution. I regret to see the names of the many members who are about to retire from the Council. That evil is corrected to a certain degree by the power of re-election. I know very well, if you can get the man who can give his time and attention to the work of the Committee, that it is most desirable to keep him. I only say I regret to see so many valuable names about to retire; I hope you will give them the praise they deserve, and I sit down by seconding the Resolution of my learned and gallant friend.

The Resolution was put from the Chair, and carried unanimously.

VII. Captain J. H. Selwyn, R.N.—

My Lord Duke, a previous speaker has said that he was perfectly ready to obey orders. I hope to show another quality which is as valuable in officers; that is, to be ready to sail at a moment's notice. I only got this Resolution put into my hand on entering this Institution, and I believe it is in consequence of the absence of the Chaplain General, who would have more fitly addressed you on the subject, that I have been called upon to move it. The Resolution refers to those gentlemen who, once a year, give us their valuable services, and who, I am happy to say, generally seem to make very short work of it, which is a very good sign of the financial state of the Institution, and also a most important sign of the clearness and accuracy with which the accounts are kept. There are some 313 working days in the year, during which there is a staff employed here to produce the fact to which the auditors give expression. A previous speaker has spoken of the candour of the Secretary as being a very good quality. I think I may add that where in addition to that candour, we find an attention to business, a courtesy and a capacity which produce such results

as those which we are now speaking of, we may say that we have got a paragon of a Secretary as well as a paragon of a Council. I do think that while we are enthusiastic about the growing prosperity of the Institution, that the labours of those gentlemen who are always here and always at work, should not be forgotten, and should receive their due acknowledgment. If the interest of the servants of the Institution is kept up by a knowledge that they share in its prosperity, I think we shall find that we have wisely employed our funds. The auditors deserve our very best thanks, and I should beg to join to them the workers who have contributed to the possibility of the auditors doing their business in so very short a time. I now beg to move the Resoution which has been put into my hands:—

"That the thanks of this Meeting be given to the Auditors for their valuable services, and that the following gentlemen be elected for the ensuing year: H. F. Downes, Esq., (re-elected), Thomas Smith Esq., Captain J. E. Dolby, and Captain J. D. Macqueen."

Vice-Admiral Sir GEORGE BACK, D.C.L., F.R.S.—

I find, your Grace, that it only wants five minutes to the hour, and I think I shall be consulting the wishes of the meeting by simply seconding the motion.

The Resolution was put from the Chair, and carried unanimously.

VIII. Rear-Admiral WELLESLEY, C.B.—

My Lord Duke, and Gentlemen,—In our bye-laws I think there is an omission which I am going to propose to you to rectify. Among our list of Vice-Patrons we have the names of many high officers of state in this country, and also the name of the Lord Lieutenant of Ireland. But connected with that large portion of Her Majesty's dominions, India, we have not the name of that high Officer who is entrusted by Her Majesty with the government of that great Empire as one of our Vice-Patrons. I have therefore to propose:—

"That in Section I., paragraph 4, of the bye-laws, after the words, 'The Lord Lieutenant of Ireland" be inserted the words, 'The Viceroy and Governor General of India.'"

Major-General BOILEAU, R.E., F.R.S.—

My Lord Duke, the Resolution which has just been proposed by my friend Admiral Wellesley is based upon official considerations, therefore it does not require any remarks from me; but I venture to assure the Institution that in Sir John Lawrence, who now fills that high and distinguished position, they may calculate upon his personal interest, altogether independent of his official position; and that on every opportunity they will derive benefit from the assistance which he is able to afford.

The Resolution was put from the Chair, and carried unanimously.

IX. Lieut.-General Sir EDWARD CUST, K.C.H.—

My Lord Duke, having already occupied your time with a previous Resolution, I will be very short upon the present occasion. If that Resolution had a tone of melancholy in it, the present Resolution is one of unmixed gratification and pleasure. It is:—

"That General Lord Hotham, M.P., be elected President of this Institution."

Lord Hotham has been my oldest and most intimate friend. We have been at school together; we have shaken hands on the battle field together; we have sat in the House of Commons on the same benches together; we have kept up our intimacy to the present time, interchanging sociabilities and hospitalities. It is unnecessary for me to occupy your time with any eulogy upon his character. Moreover, his conduct in the House of Commons is known to you. You know with

what judgment and good sense he has taken up military questions; and I am sure we could not have in our Institution one who, on public and representative grounds, could be more useful to us.

Captain Sir JOHN HAY, Bart., R.N., M.P.—

I would add very little to what has fallen from Sir Edward Cust; but one or two points I think should be mentioned to this meeting with reference to the selection which the Council have put before you. The last President was a Naval Officer. The Council thought it was but right and expedient, and I, as a Naval Officer and Chairman of the Council, was only too glad to forward their view, that the second selection of President should be from the sister service. It was also thought wise that he should be a General Officer of rank, and that he should be a person who, not taking a very strong or decided part on either side in politics, should be in that position which would give him sufficient influence, not perhaps with the Admiralty or with the War Office, but with the Woods and Forests on certain occasions that might arise. Having considered this point, and having seen the particular position which LORD HOTHAM occupies in the Army, with the fact that he also holds an old Naval peerage, we thought there was no one else who would be more acceptable than he. It might possibly have seemed, and it did seem to some, that it would have been wiser perhaps to have first of all requested His Royal Highness at the head of the Army to have accepted the post; but it will be in the knowledge of this meeting that he is already a Vice-Patron; and it was thought better to strengthen ourselves by the addition of some one who was not a Vice-Patron of this Institution. With these few remarks I will second the motion that has been made by Sir Edward Cust.

The Resolution was put from the Chair, and carried unanimously.

The noble CHAIRMAN then announced that the business of the meeting was concluded.

The Chair was then taken by Captain Sir JOHN HAY, Bart., on the motion of Rear-Admiral Sir F. E. Nicholson, Bart., C.B., seconded by Lieutenant General Stanhope.

Sir F. NICHOLSON—

The Resolution which I have to place before the meeting is one which you will all anticipate. We have a double duty of gratitude to pay to His Grace, who has presided on this occasion. He has not only found time, amidst the onerous duties of his high office, to come and preside this afternoon, but as First Lord of the Admiralty, has given us substantial reasons for gratitude to the Board. The persons who have filled any appointment under the Board of Admiralty must be well aware how difficult it is, in the face of our growing expenditure, to get even the smallest sum for many things which we are anxious to improve. There are those dockyards that some of us have had under our charge; we have always found that many of those proposals which we, in our anxious desire to improve those establishments, have placed before the Admiralty, have had those small sums remorselessly cut out before the estimates were presented to Parliament. It therefore proves how great is the estimation in which this Institution is held by the Admiralty, that His Grace should come to preside over us on this occasion, and that we are about to receive so substantial a recognition of the services which this Institution renders by spreading the knowledge we do among the naval and military branches of the profession. I have only to move that our thanks be given to the Duke of Somerset, for presiding on this occasion.

General STANHOPE—

I do most cordially second that proposal, and I am perfectly sure, from the able manner in which it has been brought forward, that it will be accepted by you with that feeling of gratitude which I think is due to His Grace, not only for presiding

over us on this occasion, but for the active and zealous support he has always given to the Institution.

The Resolution was put from the Chair, and carried with acclamation.

His Grace the Duke of Somerset—

Sir John Hay, and Gentlemen,—I am much obliged to you for the honour you have done me in this tribute of thanks. I can assure you that in acting with the Secretary of War, in the application to the Treasury for a joint grant to this Institution, I did nothing more than what I considered my duty as First Lord of the Admiralty. I am well aware, as you are also, that the position of this Institution must become more and more important. In fact, it is with this Institution as it has been with all the other Institutions in this town. Formerly, the only great scientific association was the Royal Society, but as knowledge spread and information was acquired upon different subjects, up rose the Astronomical, the Geographical, the Geological, and no end of small societies, which, as it were, branched off from the Royal Society, leaving the parent stock in order to obtain much more vigour themselves. The same want has been felt both in the Army and Navy, and it was to supply that want, very properly, that this Institution arose. If you look to the present position of the Institution, and to what it has done during the last three or four years, and see the attention which it has drawn to matters of science connected with the Army and Navy, you will see the great and growing value of this Institution. It was in that view that I recommended to the Treasury that the Admiralty and the War Office should combine to make this grant of £600 out of the estimates. I will not take up your time. I thank you sincerely for the thanks you have given me. I will only say one word with regard to the Museum. I observe that you are thinking of making a large collection of Naval models. Now, I have been a long time a trustee of the British Museum, and I know the danger of large collections. In fact our collections become so large, that we are almost pushed out of the building by them. Now, we have already got a collection of naval models at South Kensington, under the School of Naval Architecture. I would therefore humbly suggest to the Institution that they should endeavour to restrict the models that they collect here to those that are applicable to what is wanted for the day, rather than to go back and make a large collection of ancient models. The collection which is at Kensington can be seen by any member of this Institution. Her Majesty visited it the other day, and takes a great interest in it, and I have no doubt it will become very interesting as an historical collection of Naval models. At the same time a small *practical* collection with reference to the *more immediate requirements of the day* would be of great use here.

Statement of Changes among the Members since 1st January, 1864.

	Life.	Annual.	Total.
Number of Members, 31st December, 1863 ..	857	2990	3847
„ „ joined during 1864 ..	20	195	215
	877	3185	4062
Changed from Annual to Life	+4	−4	
	881	3181	4062

	Life.	Annual.			
Deduct—Deaths during 1864 ..	20	80			
Withdrawals		53			
Struck off		7			
			20	140	160
Numbers of Members on 1st January, 1865 ..			861	3041	3902

Tabular Analysis of the State of the Institution, To the 31st of December, 1864.

Year. 1st Jan. to 31st Dec.	Annual Subs. received.	Entrance Fees.	Income (from all sources).*	Life Subs. received.	Amount of Stock.	Invested in the purchase of Books, &c.	No. of Vols. in Library.	No. of Members on the 31st Dec.	Number of Visitors.
	£	£	£	£	£	£			
1831	654	..	654	1,194	..	..	..	1,437	..
1832	1,146	..	1,146	973	..	..	..	2,699	..
1833	1,405	..	1,450	692	..	..	..	3,341	..
1834	1,500	..	1,549	583	1,100	..	..	3,748	13,376
1835	1,480	..	1,574	366	2,430	40	..	4,155	8,537
1836	1,570	..	1,632	330	3,747	45	..	4,069	8,521
1837	1,549	..	1,747	222	4,747	180	..	4,164	10,907
1838	1,462	..	1,634	230	5,500	246	..	4,175	15,788
1839	1,399	..	1,565	168	5,500	292	..	4,186	16,248
1840	1,363	..	1,525	198	5,500	446	5,500	4,257	17,120
1841	1,450	..	1,643	186	6,000	243	5,850	4,243	19,421
1842	1,373	..	1,565	144	6,400	373	6,450	4,127	21,552
1843	1,299	..	1,494	140	6,700	237	7,000	4,078	27,056
1844	1,274	..	1,408	112	3,000	298	7,850	3,968	22,767
1845	1,313	..	1,466	228	1,500	127	8,100	3,988	21,627
1846	1,298	..	1,456	138	1,500	74	8,410	4,031	32,885
1847	1,314	74	1,502	132	1,700	37	..	4,017	38,699
1848	1,175	57	1,375	48	1,700	85	9,641	3,947	37,140
1849	1,176	72	1,375	84	1,150	58	..	3,970	33,333
1850	1,141	106	1,294	198	600	36	..	3,998	33,773
1851	1,136	131	1,292	66	666	34	10,150	3,188	52,173
1852	1,134	133	1,281	114	200	43	10,300	3,078	20,609
1853	1,243	319	1,684	264	528	41	10,420	3,251	25,952
1854	1,200	138	1,368	126	612	95	10,587	3,171	22,661
1855	1,159	107	1,289	120	653	55	10,780	3,131	14,778
1856	1,216	197	1,519	156	761	47	10,832	3,204	16,184
1857	1,258	176	1,937	78	1,038	40	10,960	3,168	12,755
1858	1,318	221	2,102	105	438	31	11,062	3,246	25,747
1859	1,526	195	2,277	512	946	70	11,320	3,344	28,739
1860	1,961	298	3,577	397	2,178	114	11,517	3,518	28,011
1861	2,122	305	2,899	266	2,846	99	11,812	3,689	23,296
1862	2,296	242	3,127	239	3,178	109	12,026	3,797	27,215
1863	2,379	218	3,100	405	3,583	143	12,296	3,847	18,150
1864	2,425	215	3,253	222	4,516	116	12,700	3,902	17,276

* Including Annual Subscriptions, Entrance Fees, Donations, Legacies, and Interes on Funded Property; and also the Grant from Government, commencing in 1857.

DONATIONS IN 1864.

Evelyn, C. F., Capt. 3rd Royal Surrey Militia, 3*l.*
Stevens, J. H., Maj.-Gen. R.M.L.I., 1*l.*
Wilson, J. P., Lieut. late 1st Warwick Militia, 5*l.*

NAMES OF MEMBERS

WHO JOINED THE INSTITUTION BETWEEN THE 6TH JUNE AND 31ST DECEMBER, 1864.

LIFE.

Bourne, James, Lt.-Col. Comm. Roy. Lan. Art. Mil., 9*l.*
Branfill, B. A., Capt. 86th Roy. County Down, 9*l.*
Eden, A. D., Lieut. 26th Regt., 9*l.*
Gardiner, H. L., Col. Roy. Art., 6*l.*
Hall, Marshall, Lieut. Roy. East Middx. Militia, 9*l.*
Holbrook, E. N. W., Lieut. R.M.L.I., 9*l.*
Long, Samuel, Lieut. R.N., 9*l.*
Morton, J. F., Capt. 55th Regt., 9*l.*
Sandwith, F. B., Capt. 10th Regt., 9*l.*
Tanner, J. N., Lieut. 82nd Regt., 9*l.*
Vernon, *Hon.* A. H., Capt. 2nd Derby Rifle Volrs., 9*l.*
Wilson, John P., Lieut. late 1st War. Mil., 9*l.*
Young, Allen W., Lieut. Royal Naval Reserve, 9*l.*

ANNUAL.

Abercromby, *Hon.* John, Lieut. Rifle Brigade, 1*l.*
Adams, F. B., Ens. Hon. Art. Comp., 1*l.*
Agg, Wm., Lieut.-Col. 51st King's Own L.I., 1*l.*
Alcock, Nathaniel, Assist.-Surg. 35th Royal Sussex Light Inf.
Bailey, Wm., Capt. Roy. Eng., 1*l.*
Barringer, T. S., M.D., Surgeon Hon. Art. Comp., 1*l.*
Bell, John Charles, Lieut. 53rd Regt., 1*l.*
Bell, Lynden, Major Unatt., 1*l.*
Bent, H. W., Lieut. 6th Surrey Rifle Vols., 1*l.*
Boyle, R. H., Lieut. R.N., 1*l.*
Brock, J. Arthur, Capt. 82nd Regt., 1*l.*
Broderip, Edw., Ens. 57th Regt., 1*l.*
Brooke, H., Major 48th Regt., 1*l.*
Brooke, W. L., Cornet R. H. Gds., 1*l.*
Brown, R. A., Comm. R.N., 1*l.*
Burgess, Ardwick, Capt. Q.O.L.I. Mil., 1*l.*
Bythell, R., Lieut. 56th Regt.
Cadell, Thos., Lieut. Bengal Staff Corps. W.E.
Corbett, W. A., Lieut. 62nd Regt. 1*l.*
Costello, T. M., Surg. R.N., 1*l.*
Crawley, H., Lt.-Col. ret. f.p. 20th Regt.
Crawley, T. R., Lt.-Col. 6th Inniskilling Dragoons, 1*l.*
Crowe, S. M., Lieut. Kent Art. Mil.
Cuffe, O. W., Lieut. Roy. Mar. Art., 1*l.*
Cumming, W. Gordon, Major Bombay Staff Corps.
Dando, A. C., Lt. Roy. Nav. Reserve, 1*l.*
Davenport, W. B., Capt. 62nd Regt., 1*l.*
Dickenson, P. M., Lieut. Roy. Sussex L.I. Mil., 1*l.*
Drummond, John, Lieut. late 10th Hus., 1*l.*
Dudgeon, R. C., Major 61st Regt., 1*l.*
Eglese, Joseph, Capt. Hon. Art. Co., 1*l.*
Ellison, R. G., Major h.p. 47th Regt., 1*l.*
Evans, John, Capt. 6th Inniskilling Drs., 1*l.*
Foster, J. F., Ens. Ceylon Rifles.
Fulton, J. J., Capt. Mad. Staff Corps.
Gipps, H., Capt. 9th Regt.
Goodliffe, F. G., Lieut. London Rifle Brig. Volrs., 1*l.*
Grant, Wm., Lieut. 91st Highlanders.
Gratton, A. O. D., Lt.-Col. Roy. Eng., 1*l.*
Haig, C. T., Capt. Roy Eng., 1*l.*
Hall, E. C., Capt. R.N., 1*l.*
Herbert, Arthur, Col. unatt., 1*l.*
Hutton, C. W., Capt. 59th Regt., 1*l.*
James, J. W., Comm. R.N., 1*l.*
Jones, G. P. R., Capt. Q.O.L.I. Mil.
Kain, Geo. James, Capt. 1st Middlesex Eng. Volrs., 1*l.*
Kennedy, J. J., Ens. 10th Regt.

Kidston, A. F., Lieut. 42nd Royal Highlanders, 1*l.*
Knight, H. S., Capt. 19th Regt., 1*l.*
Lee, J. E., Lieut. 55th Regt., 1*l.*
McDiarmid, H. C., Lieut. Roy. Eng., 1*l.*
MacGauran, F., Esq., Clerk, War Office.
Martin, Edw., Lieut. late 28th Mad. N.I., 1*l.*
Mayo, W. R., Esq., Dep.-Assist. Sup. of Stores, 1*l.*
Newgent, St. G. M., Major unatt. Assist.-Quartermaster General.
Newton, C. E., Major Derbyshire Rifle Vols., 1*l.*
Ouchterlony, T. H., Lieut. Roy. Art.
Panter, H. G., Major 1st W.I. Regt., 1*l.*
Pennethorne, L. P., Lieut. Roy. Art., 1*l.*
Pollard, Charles, Capt. Roy. Engineers (Bengal), 1*l.*
Pollard, H. W., Lieut. 67th Regt.
Power, W. J., Cornet 6th Inniskilling Drs., 1*l.*
Pullen, W. J. S., Capt. R.N., 1*l.*
Pulleyne, E. Lieut. 18th Hussars, 1*l.*
Ross, W. H., Capt. 23rd Bombay N.I.
Sawyer, G. W., Ens. 8th or King's.
Seton, W. C., Lieut. 82nd Regt., 1*l.*
Sherbrooke, W., Lieut. R.N., 1*l.*
Soady, F. J., Maj. Roy. Art., 1*l.*
Spence, J., Ens. 67th Regt., 1*l.*
Stewart, W. Houston, C.B., Capt. R.N., 1*l.*
Stirling, Francis, Lieut. R.N., 1*l.*
Stokes, Alfred, Lieut. 38th Regt., 1*l.*
Taylor, Rev. H. A., M.A., Chaplain to the Forces.
Tolson, W., Lieut. 35th Roy. Sussex L. I., 1*l.*
Tompson, W. D., Capt. 17th Regt., 1*l.*
Vander-Meulen, J. H., Lt. 50th Regt., 1*l.*
Voyle, G. E., Lt.-Col. Roy. Art., 1*l.*
Wahab, Geo. D., Lieut. 20th Regt., 1*l.*
Walker, A., Lieut. 79th Highrs., 1*l.*
Watson, D., Col. 82nd Regt., 1*l.*
Weatherley, F. A., Capt. 6th Inniskilling Drs. 1*l.*
Wilson, W. H., Ens., 7th Roy. Fus.
Wingfield, W., Dep. Assist. Commissary Gen., 1*l.*

ADDITIONS TO THE LIBRARY AND MUSEUM DURING 1864.

LIBRARY.

BOOKS PRESENTED.

AIDE-MEMOIRE. A L'Usage des Officiers d'Artillerie. Troisième Edition. 8°. Paris, 1856.

Dictionnaire de la Gendarmerie. 2nd Edition. 12°. Paris, 1838.

——— 2nd Edition. 12°. Paris, 1844. *Major-General Sir Alex. Tulloch, K.C.B.*

ANNALES HYDROGRAPHIQUES. No. 377. 1er Trimestre de 1864. 8°. Paris. *M. Le Ministre de la Marine et des Colonies.*

ANNUARIO Ufficiale dell Esercito Italiano 1864. Anno decimo. 1 Vol. 8°. Turin, 1864.

Annuario dell Italia Militare per il 1864. Anno primo. 1 Vol. Turin, 1864. *The Italian Government.*

Annuaire de la Marine et des Colonies. Paris, 1864. *La Direction de la Revue Maritime et Coloniale.*

ANSTRUTHER, P., Major-General late Madras Artillery. The Flight of Projectiles. Pamp. 8vo. London, 1864. 2 copies. *The Author.*

ARCHIVES of the Prussian Artillery and Engineers for 1861-62-63. 3 Vols. *The Prussian Government.*

ASTRONOMICAL, Magnetical, and Meteorological Observations made at Greenwich in the year 1862. Folio. 1864. *The Lords Commissioners of the Admiralty.*

BALFOUR, E., Dep.-Inspec. Gen. of Hosps. The Timber Trees, Timber and Fancy Woods, as also the Forests of India and Eastern and Southern Asia. 1 Vol. 8vo. Madras, 1862. 2nd Edition. *The Author.*

BLUE BOOKS:

Hudson's Bay Company. An Address of the House of Lords, dated 2nd July, 1863, for Copies of Correspondence between the Colonial Office and Hudson's Bay Company, since 1st January, 1862, relative to a road and telegraph to British Columbia—the transfer of the rights of Hudson's Bay Company to other parties.

Correspondence respecting the construction of a Telegraph line through Persia. 1 Vol. Folio. March 18, 1864.

Further Papers relating to Military Operations on the Gold Coast. 1 Vol. Folio. June, 1864. Plan to ditto.

North America. Correspondence respecting the Enlistment of British subjects in the United States Army. Folio. June 9, 1864.

Ashantee War. Copies or Extracts of any Despatches relating to. Folio. June 21, 1864.

Greenwich Hospital Return to an Order of the House of Lords, dated 16th June, 1864. Copy of the Memorandum on Greenwich Hospital. By the Duke of Somerset. Folio. June 16, 1864.

Army (India) Return, pursuant to an Address of the House of Lords, for Copies of the Despatch to the Government of India, dated 17th June, 1864. No. 194, informing them of the steps taken by Her Majesty's Government consequent on the report of the Commissioner appointed to inquire into the alleged departure from the Parliamentary guarantee to Officers of Indian Armies. Folio. June 25, 1864.

BLUE BOOKS, *continued.*

Report of Her Majesty's Commissioners appointed to inquire into the High Court of Admiralty in Ireland. 1 Vol. Folio. 1864.

Further Papers relative to the recent disturbances in New Zealand. 1 Vol. Folio. 1862.

Report on the Realisation and Distribution of Army Prize by Commissioners appointed to inquire. 1 Vol. Folio. 1864.

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ROYAL UNITED SERVICE INSTITUTION.

DESIGN.

THE promotion of Naval and Military Art, Science, and Literature is the object of the ROYAL UNITED SERVICE INSTITUTION.

The principal means by which this object is sought to be obtained are,—the formation of a Library containing Historical, Scientific, and Professional Works, Maps, Charts, and Plans; the Delivery of Lectures; the Exhibition of Inventions; and the Publication of a Journal; a Collection of Arms of all Nations; and a Museum, which shall serve as a Central Repository for Objects of Professional Information, and for Trophies and Relics, &c., connected with distinguished Officers, and Naval and Military Operations.

BYE-LAWS.

SECTION I.

1. There shall be Patrons and Vice-Patrons.

2. PATRONS: The Sovereign and the Royal Consort.

3. VICE-PATRONS: Limited to Members of the Royal Family; Officers eminently distinguished in the Service of the Country; and Members selected by the Council as having been benefactors to the Institution.

4. The following Public Officers shall be Vice-Patrons during their continuance in office:—

1. The First Lord of the Treasury.
2. The Secretary of State for the Home Department.
3. The Secretary of State for Foreign Affairs.
4. The Secretary of State for the Colonies.
5. The Secretary of State for War.
6. The Secretary of State for India.
7. The First Lord of the Admiralty.
8. The Commander-in-Chief of Her Majesty's Forces.
9. The Lord-Lieutenant of Ireland.
10. The Vice Roy and Governor General of India.

SECTION II.—Composition.

1. Princes of the Royal Blood; Lords Lieutenant of Counties; Governors of Colonies and Dependencies; Officers of the Army, Navy, Marines, Her Majesty's East Indian Military and Naval Forces, Militia, Yeomanry, Royal Naval Reserve, and Volunteer Corps, shall be entitled to become Members *without Ballot*, on payment of the Entrance Fee and Annual Subscription.

2. Retired Officers, not previously Members; Deputy Lieutenants of Counties; Civil-Functionaries who are or have been attached to the Naval and Military Departments; also the Master, Deputy-Master, and Elder Brethren of the Trinity House; and Navy and Army Agents; shall be *eligible* to become Members by *Ballot*.

3. Gentlemen above the age of *fifteen*, whose names are on the List of the Commander-in-Chief for Commissions in the Army, or who are probationary for offices connected with the Naval and Military Professions, shall be *admissible*, by *Ballot*, to become Provisional Members from year to year, on payment of the Annual Subscription; after they obtain their appointments they shall become Ordinary Members on payment of the Entrance Fee.

4. The Candidates referred to in Articles 2 and 3 must be recommended by Two Members of the Institution on their personal knowledge; the Lists, signed by the Secretary, shall be put up in the Library or Reading-room Fourteen Days before they are submitted for Election to the Council of Management specially assembled.

SECTION III.—Government.

1. The Government shall consist of a President and Twelve Vice-Presidents, and a Council of Management composed of Twenty-four Members.

2. The President of the Institution shall be elected by a General Meeting of the Members, and shall be a Member of the Council, *ex-officio*.

3. The Vice-Presidents shall be elected by the Council, of which they shall be *ex-officio* Members.

4. The Council shall be elected by the General Meeting: Eight Members shall annually go out by rotation; Three of the Members going out shall be eligible to be re-elected. The Council shall submit to the Annual General Meeting a list of

not less than ten names from which the vacancies may be filled. Vacancies that occur during the year shall be filled up at the discretion of the Council; the Members so elected going out by rotation as the Members would have done whose position they have been elected to fill.

5. After the annual meeting, the Council shall select a Chairman and Vice-Chairman for the ensuing year, one of whom, or a Vice-President, shall preside at its meetings, except when the President of the Institution attends.

6. Five Members of the Council shall constitute a quorum.

7. Two Vice-Presidents shall undertake the office of Visitors, who shall make a quarterly inspection of the Institution and its affairs, and report thereon to the Council.

8. The Council shall have the custody of the Common Seal of the Corporation, and shall have full power and authority to affix the same to all deeds, documents, papers, and writings in the name and on behalf of the Corporation.

9. The Council shall appoint a Secretary and Curator, and such other officers, attendants, and servants, as they shall think necessary for the purposes of the Institution, with full power to suspend or dismiss the same, and no such officer, attendant, or servant shall, either directly or indirectly, accept, receive, or take, from any person or persons whatsoever, any gratuity, fee, or reward whatsoever, other than and except the salary, wages, or emolument allowed by the Council.

SECTION IV.—Subscription.

1. *An Entrance* Fee of *One Pound* shall be paid by all Members on joining the Institution.

2. *Annual Subscriptions* shall be due on the 1st of January in each year: Subscribers of not less than *One Pound* a-year shall, after the 1st of January, 1860, be entitled to receive the Journal from the date of their becoming Members.

3. Annual Subscribers of *Ten Shillings* shall, after the 1st of January, 1860, receive as heretofore the Annual Report, but not the Journal.

4. After the 1st of January, 1860, all Subscribers of One Pound a-year shall, while serving on Foreign Stations, have their Subscription reduced to *Ten Shillings* a-year, commencing on the 1st of January succeeding their embarcation, if they express their wish to that effect in writing to the Secretary.

5. *Life Subscriptions.* After the 1st of January, 1860, the

payment of a sum of *Nine Pounds*, in addition to the Entrance Fee, shall constitute a Member for Life, who shall be entitled to receive the Journal from the time of his becoming a Member.

6. *Life Subscribers* of *Six Pounds*, in addition to the Entrance Fee, shall receive as heretofore the Annual Report, but not the Journal.

7. Annual Subscribers of Ten Shillings and Life Subscribers of Six Pounds, while serving abroad, shall be entitled during such service to receive the current numbers of the Journal, on notifying their wish to that effect to the Secretary in writing.

8. Members who join the Institution on or after the 1st October in any year shall not be charged the ensuing Annual Subscription on the 1st of January.

9. Members failing to pay their Annual Subscriptions shall have their names removed from the List of Members, at the discretion of the Council.

10. Members whose names have been struck off for non-payment of their Subscriptions after repeated applications, shall be re-admissible only on payment of arrears from the date of last payment.

SECTION V.—Funds and Expenditure.

1. The management of the property, receipts, and payments of the Institution shall be confided to the Council, who shall authorize every payment by an order, signed by the Chairman at the Meeting, and another Member of Council present, and countersigned by the Secretary.

2. The Royal United Service Institution neither shall nor may make any dividend, gift, division, or bonus in money, unto or between any of its Members out of its present property, or out of any property which it may hereafter acquire, and the whole of its property, both present and future, shall be exclusively applied for carrying into effect its design as an establishment for the promotion of Naval and Military Art, Science, and Literature.

3. The funds of the Institution and all Life Subscriptions and Legacies shall be invested in the name of the Corporation in eligible securities, to be selected by the Council.

4. All cash received on behalf of the Institution by the Secretary shall be paid by him to the Bankers of the Institution.

SECTION VI.—Auditors.

1. There shall be Three Auditors, not Members of the Council, who shall be elected by the General Annual Meeting to audit the accounts, one of whom shall annually go out by rotation, but shall be eligible for re-election.

2. Two Auditors shall be a quorum.

3. Vacancies that occur other than those caused by the Auditor going out by rotation shall be filled up at the discretion of the Council; the Auditor so elected going out in rotation as the Auditor would have done whose position he has been elected to fill.

4. The Auditors shall meet and examine and sign the yearly accounts, adding thereto any remarks and making such inquiries as they may deem proper.

5. After the Audit, and at least Fourteen Days before the General Annual Meeting, the Annual Report, with an abstract of the accounts and estimate of the probable receipts and expenditure for the ensuing year shall be printed and placed in the Library and Reading-Room, and may be obtained by the Members upon application to the Secretary.

SECTION VII.—General Meetings.

1. A General Meeting shall be annually held on the first Saturday in March; that day being considered the Anniversary of the Institution.

2. The Council may call a Special General Meeting, on giving fourteen days' notice—which notice must be suspended in the Library or Reading-Room, and advertised in two military papers, specifying the object or objects in contemplation, and explicitly stating that the discussion shall be strictly confined to those objects.

3. The Council shall call a Special General Meeting, on the written requisition of not less than Twenty-four Members, within one calendar month from the date of such requisition, subject to the notices and restrictions above mentioned.

4. At the General Meetings, in case of an equality of votes, the Chairman shall have a second or casting vote.

5. No Member shall be entitled to speak or vote at any General Meeting, or at any Special General Meeting, or at any adjournment thereof, unless he shall have paid his Subscriptions up to the day of payment next preceding such Meeting.

6. That any General or Special General Meeting, finding the current day insufficient for its intended purpose, may adjourn to the succeeding or any future day or days, until the business be concluded.

7. That no business shall be transacted at any Annual General Meeting other than that submitted by the Council, or by the direction of the Council, unless notice thereof be suspended in the Library or Reading-Room at least Fourteen Days prior to the day appointed for such Annual General Meeting, specifying the object or objects in contemplation, to which objects the discussion must be strictly confined.

SECTION VIII.—Making or Repealing Bye-Laws.

Should it be proposed to make, alter, or repeal a Bye-Law, the proposition to such effect, signed by the proposer and seconder, shall be suspended in the Library or Reading-Room for Fourteen Days; after which the question shall be determined by a majority of at least two-thirds of the Members present at the next General Meeting.

SECTION IX.—Mode of Voting.

All questions to be decided by a show of hands, unless a Ballot be demanded.

SECTION X.—Honorary Members.

1. The Council shall have the power of admitting Honorary and Corresponding Members.

2. Foreigners of distinction may be admitted as Honorary and Corresponding Members.

3. Eminent Individuals and Benefactors to the Institution, not otherwise eligible, may be admitted as Honorary Members.

4. The Diplomatic Body shall be invited to become Honorary members; and shall be privileged to submit the names of foreign noblemen and gentlemen, resident in England, to the Council, in order that the same courtesy may be extended to them, for the space of Three Months: this privilege to be

renewed to such strangers, if desired, on the written application of their respective Ambassadors, or at the recommendation of of some Member to whom they may be personally known.

5. Foreign Naval and Military Officers may be admitted as Honorary and Corresponding Members.

6. Ladies who contribute to the Institution may be admitted as Honorary Members.

SECTION XI.—Contributions.

The name of each Contributor shall be recorded, with a specification of the gift.

SECTION XII.—Hours of Reception—Visitors.

1. The Museum of the Institution shall be open daily (Sundays excepted) from 11 to 5 in Summer, and from 11 to 4 in Winter.* Printed tickets for the admission of Visitors are available every day except Friday, on which day a personal introduction by a Member is necessary. The names of Visitors to be inscribed in a book kept for the purpose.

2. The Libraries and Reading-Rooms shall be kept open (Sundays excepted) for the use of Members only, till 8 in the evening, or to a later hour, at the discretion of the Council.

3. The Museum shall be closed to Visitors when necessary, at the discretion of the Council.

SECTION XIII.—Expulsion.

1. Any Member who shall be removed from the Public Service for causes affecting his character shall cease to belong to the Institution.

2. In case the Council shall think it expedient to submit the conduct of any Member to the judgment of a General Meeting, the Council shall call a Special General Meeting; and in the event of its being voted at that Meeting, by two-thirds

* Winter months—October to March inclusive.

of the Members present (to be decided by ballot), that such Member should be removed from the Institution, then, in that case, the name of such Member shall accordingly be erased from the List of Members, and he shall cease to belong to the Institution.

3. In case the Member is a Life Subscriber, he shall forfeit all claim on the Institution upon his expulsion.

PRINTED BY HARRISON AND SONS, ST. MARTIN'S LANE, W.C.

ROYAL
UNITED SERVICE INSTITUTION.

Charter of Incorporation.

Victoria by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, **To all to whom** these presents shall come, **Greeting:**

Whereas our right trusty and right entirely beloved Cousin and Councillor, Algernon Percy, Duke of Northumberland, Knight of the Most Noble Order of the Garter, Vice-Admiral, and others of our loving subjects, have, by their Petition, humbly represented unto us that they are Members of a Society, established in the year one thousand eight hundred and thirty-one, under the title of "The Naval and Military Library and Museum," but since called "The United Service Institution," of which His late Majesty King William the Fourth was the founder;

That such Society has sedulously encouraged

and extended Naval and Military Science and Literature, and that it would further tend to the promotion and advancement of Naval and Military Science and Literature if we granted to the said Algernon Percy, Duke of Northumberland, and to those who are now Members of the said Society, our Royal Charter of Incorporation;

Now know ye, That We, being desirous of encouraging a design so laudable and salutary, of our especial grace, certain knowledge, and mere motion, **Have** willed, granted, and declared, and **Do** by these presents, for Us, our heirs and successors, will, grant, and declare, that the said Algernon Percy, Duke of Northumberland, and such other of our loving subjects as now are Members of the said Society, or shall from time to time become Members thereof, according to such regulations or bye-laws as shall be hereafter framed or enacted, and their successors, shall, during such time as they shall respectively continue to be such Members, be by virtue of these presents one body politic and corporate, by the name of "THE ROYAL UNITED SERVICE INSTITUTION," and for the purposes aforesaid and by the name aforesaid shall have perpetual succession and a common seal, with full power and authority to alter, vary, break, and renew the same at their discretion, and by the same name to sue

and be sued, implead and be impleaded, answer and be answered unto, in every court of Us, our heirs and successors, and be for ever able and capable in the law to purchase, receive, possess, hold, and enjoy, to them and their successors, any goods and chattels whatsoever, and as well those as now belong to the said Institution as those which may be hereafter acquired; and also to be able and capable in the law (notwithstanding the Statute of Mortmain) to take, purchase, hold, and enjoy to them and their successors a Hall or House, and any such messuages, lands, tenements, or hereditaments whatsoever as may be necessary for carrying out the purposes of the said Society, the yearly value of which, including the site of the said hall or house, shall not exceed in the whole the sum of two thousand pounds, computing the same respectively at the rack-rent which might have been gotten for the same respectively at the time of the purchase or acquisition thereof; and to act in all the concerns of the said body politic and corporate as effectually, to all intents and purposes, as any other of our liege subjects in our said kingdom not being under any disability might do in their respective concerns.

And We DO HEREBY GRANT our especial licence and authority unto all and every person and persons,

bodies politic and corporate, otherwise competent, to grant, sell, alien, and convey in mortmain unto and to the said body politic and corporate and their successors, any messuages, lands, tenements, and hereditaments, not exceeding such annual value as aforesaid.

And Our will AND PLEASURE IS, and we do further will and declare, that there shall be Patrons and Vice-Patrons, and a President and Vice-Presidents, of the said Institution, and that the said Algernon Percy, Duke of Northumberland, shall be the first President under this our Royal Charter of Incorporation, and that not more than Twenty-four nor less than Twelve Members, to be chosen by a General Meeting of the said Society, shall be the Council of the said body politic and corporate, of which the aforesaid President and Vice-Presidents shall be ex-officio Members; and, until such Members of the Council shall be elected, the present Members of the Council of the said Institution shall be the Council of the said body politic and corporate.

And We DO FURTHER WILL AND DECLARE, That there shall be a General Meeting of the Members of the said Society once in each year or oftener, and that if necessary the same shall be adjourned from time to time, and that the said General Meetings and the Council shall have the entire direction and manage-

ment of the concerns of the said body politic and corporate, in the manner and subject to the regulations hereinafter mentioned.

And We DO FURTHER WILL AND DECLARE, That the said General Meetings shall from time to time make and establish such bye-laws, and vary, and alter, and revoke the same, as they shall deem to be useful and necessary, for the election of President, Vice-Presidents, and Council, and for the regulation of the said body politic and corporate, for the admission and expulsion of Members and of honorary and foreign Members, so that such bye-laws be not repugnant to these presents, or to the laws and statutes of this our realm; and shall and may also enter into any resolution and make any regulation respecting the affairs of the said body politic and corporate that may be necessary and proper, and shall not be repugnant to these presents, or to the said laws and statutes.

And We DO FURTHER WILL AND DECLARE, That the General Meetings and adjourned General Meetings shall take place at such time as may be fixed by the said Council, and that the present rules, regulations, or bye-laws of the said Society, so far as they are not inconsistent with these presents, shall continue in force until the same shall be altered by a General Meeting.

And We DO FURTHER WILL AND DECLARE, That notwithstanding anything herein contained, the Council shall have the sole management of the income and funds of the said body politic and corporate, the appointment of Secretary, Curator, and such officers, attendants, and servants as the Council shall think necessary or useful; and also the entire management and superintendence of all the other affairs of the said Society; and shall and may, but not inconsistently with or contrary to the provisions of this our Charter, or any existing bye-law or laws, or the laws and statutes of this our realm, do all such acts and deeds as shall appear to them necessary for carrying into effect the objects and views of the said body politic and corporate.

Provided always, and we do further will and declare, That the Council shall from time to time, and at least once in each year, render to a General Meeting a full account of their proceedings, and that every Member of the Society may at all reasonable times, to be fixed by the Council, see and examine the accounts of the receipts and payments of the said body politic and corporate.

And We DO FURTHER WILL AND DECLARE, That no sale, mortgage, incumbrance, or other disposition of any messuages, lands, tenements, or hereditaments belonging to the said body politic and

corporate shall be made, except with the approbation and concurrence of a General Meeting.

And We DO FURTHER WILL AND DECLARE, That it shall be lawful for the Council of the said Institution, with the approbation and concurrence of a General Meeting from time to time to appoint any persons to be Trustees of any part of the property of the said body politic and corporate, and to make, or direct to be made, any conveyance or transfer to such Trustees.

In witness whereof we have caused these our Letters to be made Patent.

Witness Ourself, at Our Palace at Westminster, this twenty-second day of February, in the twenty-third year of our reign.

By Her Majesty's command,

Edmunds.

Seal.